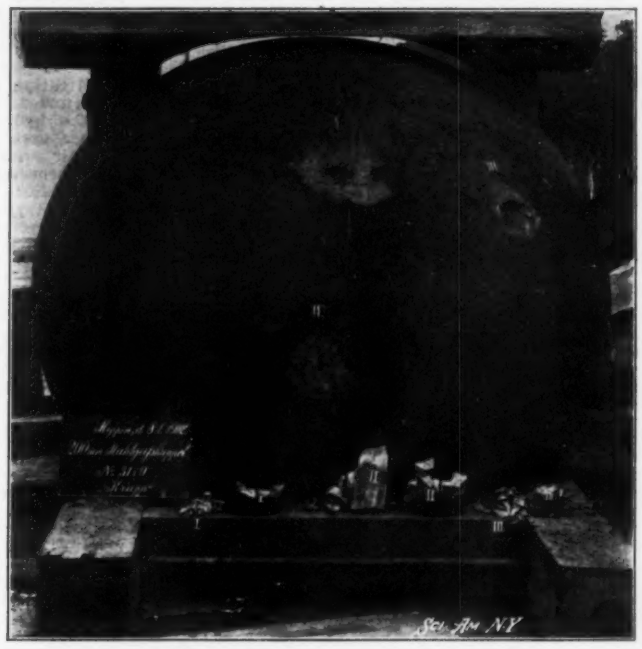
SCIENTIFIC AMERICAN SUPPLEMENT. No. 1427

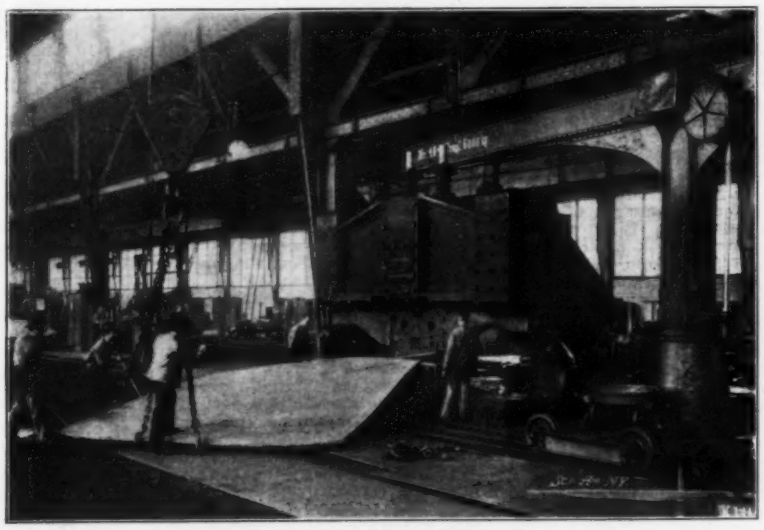
Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1903, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol LV. No. 1427. NEW YORK, MAY 9, 1903. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

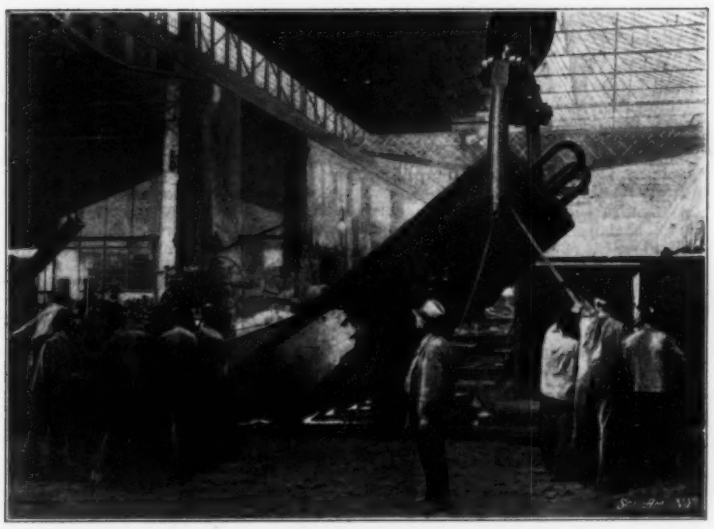
STREET IN BAUMHOF, ONE OF THE COLONIES ESTABLISHED FOR KRUPP WORKMEN.



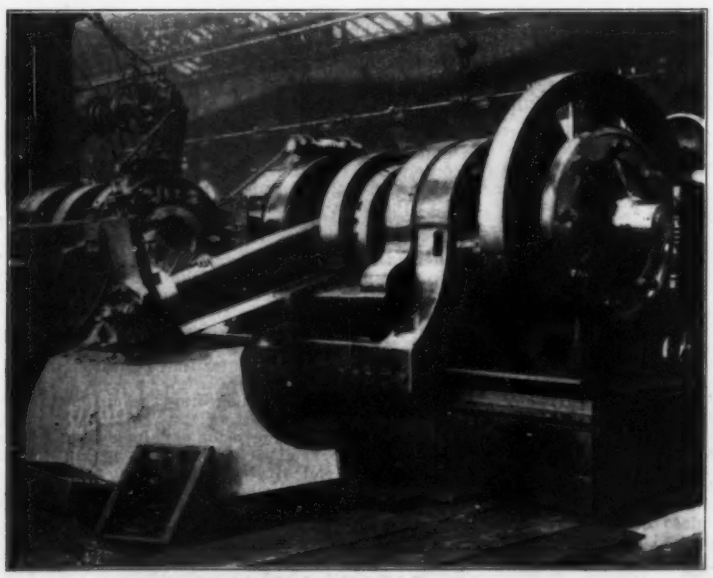
EFFECT OF PROJECTILES ON SPHERICAL ARMOR.



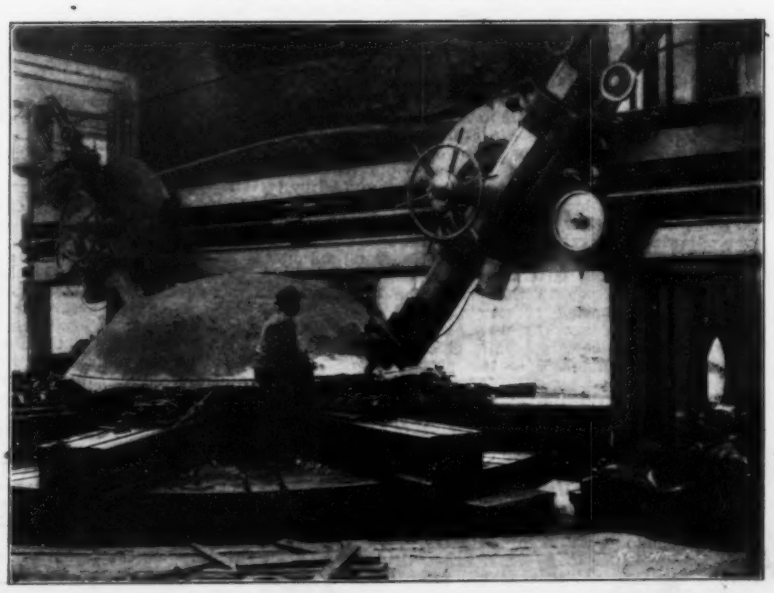
HEAVY PLATE SHEARS IN SERVICE.



HANDLING AN 85-TON ARMOR-PLATE CASTING.



SHAPER AT WORK ON CURVED ARMOR.



MASSIVE DOUBLE TOOL FOR TRIMMING EDGES OF SPHERICAL ARMOR.

THE KRUPP WORKS AT ESSEN.—I.

THE KRUPP WORKS AT ESSEN.—I.*

By DAY ALLEN WILLEY.

THE Krupp works may be termed one of the national industries of Germany, not only by reason of their magnitude, but from the fact that the empire depends so extensively upon them as a source of war material and for the development of its navy. This monument to the ability and genius of the Krupp family has undoubtedly played a most important part in encouraging the industries of Germany, as is evidenced by the increase in iron and steel shipbuilding establishments alone. Up to 1870 the country contained but seven of these establishments, representing a capital of 4,800,000 marks. In 1890 the number, including the Kiel yard, had increased to twenty-five, representing 36,000,000 marks investment; while at present thirty-seven are in operation, with a capital of 66,000,000 marks. These figures do not include the additions which are to be made to the Kiel plant in the near future.

The works at Essen and Kiel have earned such a reputation for the manufacture of ordnance, ammunition, and various types of warships that the variety of their production for other purposes has not perhaps been thoroughly appreciated. The principal product is of course steel; but in addition to the crucible, which is the oldest specialty of the steel plants, open-hearth, puddled, and Bessemer are also turned out in very large quantities, as well as castings representing combinations of the crucible and Martin steel, alloys of steel with tungsten, nickel, chrome, etc., and bronze for propeller blades, also specially hard steel intended for the manufacture of crushing machinery, dredges, burglar-proof safes, and for the steel trade in general. A few of the specialties which are made at the various plants controlled by this corporation indicate the facilities which are possessed. Not only stationary and marine engines, but parts for locomotives are built, as well as hoisting machinery, ship plates, the metal work of railway cars, such as wheels, springs, and axles, building material, electrical apparatus, all of the metal work entering into the construction of railroads, such as rails, ties, and fish plates. A very large percentage of the steel product is sold in Europe and exported to this country in the form of bars and sheets. It may be added that a large tonnage of both wrought and cast iron is produced annually to be sold for various purposes.

Since Peter Friedrich Krupp founded the works which bear his name, in 1810, erecting the first smelting furnace for the manufacture of cast steel a year later, the enterprise has expanded until it represents to-day four steel and iron works, one of the largest shipyards in Germany, three groups of coal mines, and sixteen blast furnaces, taking the product from no less than 667 ore workings in Germany, in addition to a large tonnage annually secured from the workings in northern Spain. All told, no less than 150,000 persons depend upon the several industries for support. Of these, 40,000 are skilled and unskilled workmen, and about 4,000 are employed in various clerical capacities. The Essen plant is by far the largest, requiring about 25,000 hands. At present 3,000 are employed at the Gruson division, about 4,500 in the shipyard, while the coal and iron mines require a force of 6,000, and the blast furnaces and other works about 5,500. The army of employés with their families constitute important communities in themselves, those employed at Essen residing in eight suburban colonies. Another community is peopled entirely by the miners, while the shipyard workers also form a separate town in themselves.

The Essen works have been so prominently identified with the progress made in the construction of ordnance, ammunition, and armor plate that it is interesting to outline their history briefly. To-day several of the shops which were built at Essen in 1818 are still standing and being utilized for various purposes. The first cast steel was converted into a cannon at this plant when the three-pounder gun was finished under the supervision of Alfred Krupp in 1847. The use of cast steel in small-arm barrels was first tried here with success in 1843. With 1853 came the manufacture of weldless steel tires, which attracted so much attention from engineers. The first 12-pound cannon was finished in 1854 at Essen, while in 1862 began the casting of Bessemer steel in Germany. To-day the Essen works have the facilities for manufacturing ordnance of every type, ranging from the one-pounder rapid-fire gun used in the fighting-top of the warship to the sea-coast defense gun, and the main battery of the first-class battleship. The coast-defense turrets are finished at the Gruson works, but armor plate of every type for naval use is completed at Essen, as well as hardened steel castings for war vessel protection. As an indication of the capacity of the Essen plant alone, it may be stated that up to the present time, it has completed about 40,000 guns for naval and coast defense, in ordnance for siege and fortress purposes, and in batteries of field and mountain artillery including the necessary gun carriages and other accessories. Here are also manufactured shells for piercing heavy armor plate as well as ordinary steel projectiles, mining shells, shrapnel, and even a large quantity of cast-iron shells and cast shot are turned out yearly, in addition to fuses and ammunition. The Gruson plant may be termed supplementary to that at Essen in the production of war material. The celebrated turret takes its name from the founder of these works, which are located at Buckau. The turrets are composed of chilled cast iron, and are utilized principally for the protection of coast-defense guns. Another form of turret manufactured at Gruson is provided with a steel top and a glacis armor of chilled cast iron or cast steel. Armor for the protection of observation stations is another product. The Buckau division is equipped with machinery for manufacturing small cannon, as well as carriages and ammunition for them.

With the Annen works it may be said to supplement those at Essen. As may be imagined, castings of iron and steel made at Essen form the base of most of the material which comes from the Gruson works. Chilled iron is used in crushing rolls, breaker jaws, and other apparatus requiring special hardness of metal. Here are also produced forgings in steel and homogeneous iron, steel castings for marine work, as well as plates and electrical machinery, material for railways, hoisting cranes, rolling mills for various metals, hydraulic presses and mining machinery of all kinds, as well as complete plants for the manufacture of gunpowder and other explosives and oil mills. Thus it will be seen that the Buckau section of the industry is one of its most important.

While the Essen works may be called the pioneer of the group of Krupp industries, it is interesting to note that they have kept pace with the improvements perfected in equipment for producing metal in its various forms. The crucible, open-hearth, and Bessemer sections are equipped with the most modern machinery for these purposes. The first-named plant is capable of casting single pieces from the greatest number of crucibles of any steel works in the world, turning out ingots weighing 85 tons and over. The furnaces are served with power cranes; electricity being principally employed as the motive power. The machinery for converting the raw material into armor and other plates includes no less than twenty-two trains of rolls, steam hammers, whose "tups" weigh from 100 pounds to 55 tons, and two forging presses for treating armor plate, representing a power of 5,000 and 2,000 tons respectively. They are operated by the hydraulic system, as well as two bending presses, each of 7,000 tons. These presses are similar in their principal features to the ones in service in Bethlehem and the Carnegie works in the United States. For transferring the ingots, armor plates, and other heavy machinery, electrical overhead traveling cranes are principally used, supported by the framework of the buildings where they are installed and serving all parts of it. The larger ones have a lifting capacity of 165 tons. The machine tools employed form one of the most interesting portions of the mechanical installation, as might be imagined. The large quantity of heavy armor plate which is finished in this department necessitates unusually powerful drills and lathes. These are operated by steam power, also by individual electric motors, directly connected or belted to the mechanism. The turrets are finished by what may be termed a double tool, the cutting parts of which are fastened to cylinders traveling on a horizontal serrated platform and suspended above the material to be treated. The turret is bolted to a revolving framework, which can be adjusted to the cutting tool as desired. Probably the most powerful horizontal lathes in the world are used at the Essen shops in both armor plate and turret work.

The Essen works alone are divided into no less than sixty different departments. The steam power is furnished by plants containing 327 boilers developing about 37,000 horse power in all, distributed among 500 engines ranging from 2 to 3,500 horse power each. While steam power is used for operating a considerable portion of the machinery, the electric motor is gradually being substituted for it, and at present about 275 are in service. The immense horse power referred to is required not only for the various machine tools, of which over 5,000 are in service, but 141 steam hammers, all of the presses, which comprise no less than 63, being worked by hydraulic power. The annual fuel consumption of these works represents about 765,000 tons of coal and 475,000 tons of coke, in addition to 7,000 of briquettes, or 75 per cent of all the fuel utilized by the group of industries. The fire brick and crucibles for the Essen works require a special plant which produces 2,000 crucibles daily.

While the Essen division covers an area of 1,800 acres, the Gruson works, including their proving grounds, represent an area of 116 acres, but comprise no less than fifty different departments. While the mechanical equipment is not as elaborate as that at Essen, the division includes 100 furnaces for both iron and steel, 66 steam engines, and 376 cranes, including the electric and hydraulic transferring and hoisting apparatus, which has a capacity up to 150 tons. Much of the material, however, is conveyed by a narrow-gage railroad extending to the principal shops, and on this is transported the turret work, which is received in the rough from Essen for finishing. Interesting features of this section are two chemical laboratories and testing stations, where machinery intended for crushing or ore dressing is treated to a series of elaborate experiments to determine its strength. A specialty is made of recent inventions, to compare their merit with other apparatus for similar purposes. The Annen plant, although small when contrasted with the other establishments, supplements the former in producing Siemens-Martin steel castings for marine work, locomotives, and stationary engines. The works include three Siemens-Martin furnaces of the most modern type, two steel furnaces having a capacity of 100 crucibles each, four heating furnaces, and a roller mill producing steel for small arms.

(To be concluded.)

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

SOME PROPERTIES OF THE RADIATION OF RADIO-ACTIVE BODIES.*

1. *Characteristics of the Radiation of Uranium.*—I have shown previously that the radiation of uranium was deviated by a magnetic field; the observation was made from the action of this radiation on a photographic plate. This having been covered with black paper, I was not able to ascertain whether there existed in the radiation in question a part not deviable and quite absorbable, a part which is very intense in the radiation of radium, but which is arrested by the black paper.

I have lately resumed for uranium an experimental arrangement which I had already employed for radium. In the uniform field of a permanent magnet, a small block of lead is placed containing the active matter in a rectilinear depression about 1 mm. wide and situated parallel with the field. Above this source, a very fine slit, made in the glass or in the lead, diaphragms the pencil of rays emitted in a plane parallel to the field. Above the whole, a photographic plate not covered is placed, cutting normally the plane of the pencil before its deviation, and more or less inclined to the field. If the radio-active matter is spontaneously luminous, the light is eliminated by covering the source with a thin sheet of aluminium 0.01 mm. thick, which allows almost all the radiation to pass.

Under these conditions I recall the fact that if the source is radium, there is observed at the end of a few minutes of pose, on one hand a very strong rectilinear impression corresponding to the rays not deviated by the magnet; then, on the other hand, a diffuse impression deviated by the field, corresponding to the rays unequally deviable, of which the trajectories traced tend the more to become circumferences of circles, as the position of the plate is nearer being normal to the field. If a sheet of black paper, or an aluminium sheet 0.1 mm. in thickness, is interposed, the deviable part alone appears. However, if the experiment is prolonged for several days, a rectilinear impression is seen, corresponding to other rays not deviable and very penetrating.

I recall also the fact that polonium does not emit deviable rays, and that the radiation of this product is arrested by a sheet of paper.

I have obtained with uranium under the conditions described images which have been developed; one after twenty days, and the other after forty-two days of pose. The magnetic field has an intensity of about 1,350 units C. G. S. The two images show that all the active radiation has been deviated. Although the photographic plate had received the radiation without the interposition of any screen, there was no appreciable trace of impression by the rays not deviable.

This absence of impression does not allow of deciding anything concerning the existence of very penetrating non-deviable rays, for this part of the radiation is so long in impressing the photographic plate, even with an intense source like radium, that to discover it in the radiation of uranium, poses considerably longer than those which took place would have been necessary.

The case is not the same for the part non-deviable and quite absorbable. This with radium gives an impression much more intense than the deviable part, and in the trials with the radiation of uranium the photographic plates should have been impressed. It must therefore be concluded that it does not exist in the radiation of uranium, or that if it exists, the part not deviable and slightly penetrating is not emitted with an intensity, of which the ratio with the intensity of the deviable part is of the same order of extent as for the radiation of radium. I have observed previously that a thickness of 1 centimeter of air absorbs more than a third part of the activity of uranium in the ionization of the air. It seems therefore that if this absorption arrested the part not deviable this must be due to impressing the photographic plate in the regions which are only a few millimeters distant from the source.

Making under these identical conditions images for comparison with radium, it was ascertained that the impression obtained with the deviable radiation of uranium is due principally to rays similar to those of the less deviable part of the radiation of radium, characterized by curved rays, of which the value multiplied by the intensity of the magnetic field is comprised between 1,500 and 2,000 units C. G. S. for the region of maximum impression. The existence of these very penetrating rays characteristic of the radiation of uranium is conformable to the results which I have already observed.

Still it may be said that, as this is presented in the position of the maximum of intensity in the spectra of the luminous rays, the region of maximum impression depends both on the special activity of each single ray and on the law of dispersion by the field; that is to say, on the manner in which the energy is distributed over each unit of surface of the plate, and in which it is absorbed by the impressionable matter. The region of the maximum tends to be displaced in the direction of the rays less deviated.

Outside of the enormous difference between the intensities, the absence of a part of the non-deviable radiation establishes a new profound difference between the radiation of uranium and that of radium.

2. *Action of the Radiation of Radium on Phosphorus.*—After having shown that the obscure radiation of radium converts white phosphorus into red phosphorus, I have tried to analyze this phenomenon and to ascertain at least partly the nature of the active rays. In a flat glass cell 1 mm. in thickness, of which one face was formed by a very thin plate of mica, white phosphorus was poured and then covered with a layer of glycerin. The cell was adjusted vertically against one of the armatures of a magnet, giving a field of about 400 units C. G. S., then at the upper part was placed a horizontal linear source, normal to the cell and parallel to the field. The active matter consisted of radium chloride, contained in a little glass tube 1 mm. in diameter, and surrounded with a sheet of beaten aluminium wrapped several times around the tube in order to arrest the light emitted; two successive slits, 15 mm. distant, made in the lead plates and parallel to the tube, limited the emission in a plane parallel to the field. The radium was inclosed in a sealed tube and placed above the phosphorus in such a manner as to be protected against an accidental ignition of the phosphorus during the long period of the experiment. The presence of the glass tube arrested the very absorbent non-deviable part of the radiation as was clearly proved by afterward substituting for the cell a photographic plate.

Under the conditions which have been described, there was seen at the end of a few weeks a red mark on the white phosphorus, showing the conversion effected by the deviable part of the radiation; a mark superposable on the impression obtained on a photographic plate for comparison. The experiment was arrested at the end of sixty days. The non-deviable very penetrating rays, whose impression appeared on the photographic plate only after two days of pose, did not have any appreciable action on the phosphorus. On the contrary, the secondary rays emitted by the lead were very active; it is known that these rays are slightly penetrating and very absorbable.

It is therefore demonstrated by this experiment that

* From the French of M. Henri Becquerel. Memoir to the Académie des Sciences.

the deviable part of the radiation of radium, identical with the cathodic rays, converts white phosphorus into red phosphorus. It is very probable that the non-deviable and very absorbable part would be likewise very active in effecting this conversion; but the necessity of protecting the radium against an accident during the experiment occasioned the employment of a glass tube, which arrested this latter radiation.

REFLECTIONS ON TELEPATHY.

By Prof. JOHN TROWBRIDGE.

ON the Italian side of the Alps there is a little chapel which is a type of many others scattered on the slope of the mountains. Its bell has for ages called together the peasants for their morning and evening devotions. It has its shrines for votive offerings, and its precious relics before which one can see the devout worshipers with countenances pathetically wrought with religious fervor. Around the picture of a saint are crutches and canes, mute testimonials of the cures wrought by an enduring presence in the minds of the believers. In the Middle Ages the only light before the altar was a dim taper. Now an electric light swings before the shrine, fed from a far distant waterfall, almost in the clouds, nourished from the eternal snows. My friend and I had been reflecting upon the possibility of transmitting energy from such abundant sources over the entire continent of Europe, and, as we rested in a corner of the chapel, my companion pointed to the electric lamp, and remarked that men in the Middle Ages would have regarded the possibility of lighting the chapel from a distant waterfall by a mysterious influence transmitted over wires, much as the cynic now regards the possibility of telepathic communication with friends in China. "Just as the humble peasant," said my friend, "puts herself in spiritual communication with a higher power, so may we not find a way to telepath to minds that are attuned to ours?"

The thought thus expressed is in the minds of most of our acquaintances; and when we reason with them and apparently convince them of a lack of evidence, the conversation generally ends by their relation of a marvelous tale of telepathic communication which has happened to them, or more often to a friend, and the story is told with a frank disregard of the laws of evidence. The late advances in the subject of wireless telegraphy have led to a greater confidence in the truth of telepathy. One often hears the remark, "Why is the possibility of the communion of one mind with another without the use of electricity more marvelous than wireless telegraphy?"

It must be confessed at the outset that there is at present no evidence of telepathic communication which would be accepted in a court of law in regard to property, or in a scientific laboratory. The evidence which is adduced and submitted to societies of psychical research cannot be compared with that of the simplest analysis of a chemical compound, or that which gave men the suspicion of the electric action excited by the motion of a magnet. I shall return presently to the fallibility of so-called psychic evidence; at present I wish to dwell upon the utter lack of history in the subject of telepathy as a scientific fact. It is one of the chief characteristics of a science that it has a history, and no subject can arise to the dignity of a science unless it has at least the rudiments of a history. Wireless telegraphy has a past, and is the result of the patient study of almost countless facts, gathered by thousands of workers in laboratories. These facts and phenomena can be studied and the phenomena can be repeated by any skilled person. Telepathy has no history, and if it should be ascertained to-morrow that it is possible, it will be the first instance in the history of science of the discovery of a new manifestation of energy or of a new law of nature which had not been preceded by the patient study of repeatable phenomena. It is therefore safe to prophesy that telepathy will not be a fact until it has a history of repeatable phenomena.

It would seem that abundant opportunity has been offered for the accumulation of reasonable evidence of the action of one mind on another during the past hundred years of active intellectual scientific inquiry. Moreover, the hosts of card players, since the beginning of the powers of ratiocination in man, have been in an attitude of interested attention in regard to the action of one mind on another. Telepathic communication would be of great advantage to the gambler, and to the speculator who plays a larger game on the Stock Exchange. However the latter may romance in regard to telepathy at the club, he never relies upon it where dollars and cents are involved.

We must confess that there is no science in the subject of telepathy; it is a belief. When we examine the grounds of this belief, we naturally ask ourselves, How do we communicate with kindred spirits with even the full use of our faculties of seeing and hearing? Do we not judge of a friend's opinion more by the tones of his voice, the lifting of the eyebrows, the gestures of the hands, than even by his words? When he rings us up on the telephone, we gather his meaning by the accumulated memories of the look which habitually accompanies his speech—his smile, whether it be cynical or optimistic. Two deaf, dumb, and blind persons are not conscious of proximity except from the sense of touch. When we express a belief in telepathy, we indulge in a hypothesis of an occult radiation of vibration of a mind cell, far off in China, perhaps, which can affect another mind cell at the antipodes; and we profess a belief that this radiation, like that employed in wireless telegraphy, can set a mind cell in action and communicate the senses of sight, hearing, and the tactile sense. Otherwise, how can we recognize a friend or penetrate his meaning? This is a large hypothesis; it is not in consonance with scientific thought; it belongs to the realm of demonology and witchcraft. Remember, we are not stating our conviction that telepathy is not possible; we are merely saying that if telepathy becomes an acknowledged fact to-morrow, it will be an unprecedented fact in the history of the scientific advance of the human race. There are, doubtless, more things in heaven and earth than are dreamed of in our philosophy; psychic philosophy seems to have taken these words to heart, and is more than ready to substitute intuitions for strenuous scientific investigation. It must be remembered that there are no limits to scientific inquiry, but there are fatal limits to metaphysical speculation.

My friend, while we rested in the little chapel, dwelt upon the dim beginnings of all sciences, the mystical awakenings to the realization of the presence of new phenomena. He dwelt upon Faraday's seeking for the evidence of invisible lines of force seeming to stretch out from wires along which an electric current flows. We now know that such invisible lines emanate from Marconi's masts, and, passing through empty space, hold in their embrace the distant receiving mast. "Is not," said my friend, "the groping of Faraday to discover such lines of force like the groping of the physical philosophers to discover the evidences of telepathy?" I answered: "There is no scientific resemblance between the methods of inquiry. Faraday consulted the history of preceding phenomena, and used instruments which had been perfected by systematic study, and without which his discoveries would have been impossible. Moreover, he was trained in scientific observation, and understood that when he entered his laboratory he must leave his intuitions with his coat and hat outside, together with his imagination—both, it may be, to be taken up on leaving, but never to be allowed in the strict limits of the workshop."

My friend, more than half a believer in telepathy, remarked: "Have there not been accidental discoveries? Did not Daguerre discover by accident the wonderful art of photography? Is telepathy stranger than the property of silver to hold for years an invisible image of a friend on what seems to the eye an absolutely blank surface; yes, to hold it for centuries in a sarcophagus on the bosom of a mummy, to be revealed by merely pouring a fluid over it?" Did not Röntgen find a mysterious image on such a photographic plate which has been exposed by accident to the mysterious light from an electric discharge?"

"It is true," I replied, "that many phenomena have been discovered by accident; but only those which have been recognized by scientific observers, or, what is much the same, skillful observers, have come to fruition. An untrained man would, doubtless, have attributed Daguerre's phenomenon to the spirits. Daguerre's method of following up the accidental discovery is much to my point. Having left a plate of silver exposed in his dark room for some hours, being interrupted by a caller—the blind instrument of fate sometimes called a bore—he returned, and, to his surprise, found an image on the plate. It had evidently been formed by something in the dark room. He proceeded laboriously to try every chemical or substance there was on his shelves, without effect; he then got down on his hands and knees and searched the floor. In a corner he observed some globules of mercury. He had arrived at the end of his research. Mercury was the substance which had quickly brought out the mysterious image. Röntgen also was a skilled observer, and his study of the accident is a model of accurate observation. The accident was followed by the scientific method of patient inquiry. How many accidents have fallen to men who have not seen their import! How many have come to men who have been intellectually asleep! Hawthorne, with his wonderful insight, has, in an allegory, depicted the opportunities that were offered to the sleeping youth, and the allegory fits the intuitional man who has no training to follow up an observation."

My friend was not converted by my reasoning, and I continued in a somewhat intolerant manner, using unguardedly the word Science in speaking of telepathic science. "I use the word 'Science,'" I explained, "for, under the name of 'absent treatment,' it is called science by certain persons. Absent treatment presents in a concrete form the popular belief in the action of one mind on another at a distance. It assumes what is totally unproved, and its believers employ the word 'Science' to give respectability and credence to what has no claim to be called a science. Absent treatment is credulity masquerading in the garb of Science."

Telepathy has no instruments for measurements; it has no reagents; it has no history of past phenomena leading up to a possibility. Its believers carry their intuitions into their study rooms, or what takes the place of laboratories. It is a subject generally in the hands of persons discredited as trained observers. The only methods of inquiry are listening to the stories of hallucinations, and what may be called the postal-card method of collecting information—a method which permits the romancing correspondent full scope, and results in the collection of a large amount of fallacious statistics. What weight should be given to the answers of untrained observers whose antecedents, early education, and environment are unknown to the collector of such statistics? Reflections upon the possibility of telepathic communication leads one in general to scrutinize severely the weight of evidence presented by the believers. Let us, for instance, contrast the evidence for the true value for the specific gravity of lead with the evidence for telepathy. Scores of scientific observers have measured the weight of lead in comparison with that of water, and have compared their results with the strictest impartiality. The faults of the instruments employed in the measurements are given, and complete information is afforded of the means that are taken to arrive at a result which shall not be influenced in the slightest degree by the personality of the observer. There has been no secrecy, no claims for the mystical effect of moods. Compare this method with that of the physical observer who brings forward telepathic evidence. Suppose this evidence consists of a message between friends separated by seas and continents. In the first place, is the probability of coincidences given due weight? Is the astronomical difference in time between the places calculated? In order to be scientifically accurate one must be able to measure this time to at least the thousandth of a second, and this measurement cannot be made by the ordinary psychical observers. How much credence can be given to what is called corroborative evidence, such as the description of a witness at the deathbed and the conversation of those present? How much of this is subsequent cerebration; and what care has been taken to prevent the unconscious collusion of the witnesses and the romancing after the event?

Scientific men are sometimes counted among the believers in telepathy. We must remember that laboratory investigation is so strenuous that many men who have made their reputations by accurate work, in advancing years abandon labors which yield at the best small, though precious, returns, for they find it easier to philosophize and to write out their thoughts than to put them to the test of experiment. When a scientific man takes to such work in psychics and philosophy, the death knell of his scientific career is rung.

My friend and I left the little chapel on the Italian side of the Alps; he with still a belief in telepathy, and I with the reputation of being more or less of a materialist. I have grown to regard this term as one more or less complimentary to one's discriminating faculty.—The Evening Post.

THE CONUNDRUMS OF RADIUM.

THE general facts of the curious properties of radium are probably known to every one who keeps in touch with current technical literature. The more it is studied, however, the more remarkable it becomes from every point of view, and the results of recent experiments with it are so startling and threaten to undermine so many of what have come to be regarded as the basic truths of physics that even those for whom radium has no immediate or practical interest should be advised of its surprising phenomena. At the moment pitch-blende is the storm center of scientific controversy and the focal point of scientific interest. In it may lie a new source of power which will revolutionize not only mechanics, but possibly physics and chemistry as well.

Up to quite recently radium was regarded much as calcium chloride had been in the days when luminous paint was a curiosity. It was known to possess the power of radiating light, but was supposed to possess this quality by reason of the fact that it had absorbed light from the sun's rays. The extremely interesting discovery of Sir William Crookes that the ions, or atomic emanations from radium could be rendered visible changes the point of view from which this extraordinary mineral must be regarded. Prof. Lippmann of the Sorbonne, whose standing in France is equivalent to that of Lord Kelvin or Lord Rayleigh in England, seems to have established the fact that radium has the power of continually generating heat without drawing upon any external source of energy. If this be true, every one with the least or most superficial knowledge of physics will see at a glance that this phenomenon gives us a new science and compels a revision of our accepted ideas on many subjects. As has frequently happened before, Crookes' discovery of the heat-generating properties of radium, while it comes like a revelation, is merely the recognition of properties inherent in many kinds of matter, and previously suspected, if not accurately described. The difference appears to be that radium possesses these properties in higher degree than any other substance at present known. Some of our readers, with a taste for excursions into the by-paths of scientific literature, will perhaps recall the generalization of Seguin in explanation of a phenomenon which had puzzled the physicists. It was noticed many years ago that a coin or a print, if shut up in a box in proximity to, though it may not be in contact with, a sheet of blank paper, was found in time to have impressed its own image upon the blank sheet by a process of photography chiefly, if not exclusively, operative in the absence of solar light. These pictures were at first regarded as profound mysteries, explainable only by assuming that superhuman agencies had produced them. Seguin suggested the explanation that the bodies capable of producing this phenomenon did so by giving off a stream of impalpable particles projected from themselves with high velocity, and that these particles were capable of producing an impression upon what they bombarded. His hypothesis was received with hilarity by the physicists, to whom the idea of such a radiation of matter, even in infinite attenuation, going on forever without any sensible loss of weight or bulk in the mass drawn upon, was inconceivable. For that matter it is inconceivable still, but it is becoming evident that Seguin discovered the only explanation of a series of phenomena which find their highest known development in the behavior of uranium and radium. The matter was practically forgotten until 1896, when Becquerel, in the course of some interesting and important experiments with the salts of uranium, observed that they maintained a constant radiation, that the rays thus given off possessed in common with the X-rays of Röntgen the astonishing power of passing through substances distinctly opaque to solar radiation, and that the rays thus transmitted through plates of metal, for example, were able to make a distinct impression upon a sensitive plate which would be acted upon by the actinic rays of solar light. If a small mass of uranium was inclosed in a light-tight box with a photographic plate, and an opaque object was interposed between them, the form of that object was distinctly reproduced upon the plate as in the shadow pictures of the Röntgen skiagraphs. The novel feature of the radiation from a crystal of any of the uranium salts was that apparently no exciting cause was needed to produce or maintain it. In the case of the Röntgen rays the application of external energy is necessary to excite the vacuum tube and produce the X-radiation. Uranium, however, has this energy within itself. Its radiation appears to go on continuously and is apparently unaffected by any treatment to which the crystal is subjected, such as heating, electrification or solution in acid. If this be true, and all observations thus far made warrant the belief that it is, the axiom of physics that all energy is but the mechanical equivalent of energy previously exerted to produce it, and that all work is but a credit to balance a debit previously recorded, would seem to need revision. The later experiments of Becquerel, and of M. and Mme. Curie, with uranium and the last addition to the group of elements found in association with it, radium, give us phenomena which in their relation to other phenomena so universal as to warrant the formulation of laws which have thus far not only passed unchallenged, but have satisfactorily accounted for pretty much everything dynamical, may very well pass to classification as miraculous. The fact that they are not miracles, but are manifested in obedience to a well established

natural law of invariable operation, has caused the physicists to look at one another and ask if it can be true that modern science has builded upon a cornerstone which has crumbled under it.

The assumption that the Becquerel rays, which have been recognized as originating in certain new elements of which radium is the most active of those thus far known, are not streams of material particles forever flowing from their source without diminution or change, but mere vibrations of ether, like the Hertzian rays employed in wireless telegraphy, would have saved a great deal of trouble, but unfortunately this was rendered untenable by the discovery that if such a stream of radiant energy was allowed to fall upon an electrified body it would discharge it precisely as a jet of tangible water would do. And now Crookes has made these rays visible, and Professor Lippmann has established the fact to the satisfaction of the French Academie des Sciences that radium is capable of producing sensible heat *ad infinitum*, without consuming itself or anything else so far as can be determined.

Whether these discoveries have any economic value or not is of less immediate concern than the effect they will have on science. A century ago they would have been regarded as establishing the hypothesis of phlogiston as a property of certain kinds of matter, and we should be compelled to regard radium as the most highly phlogisticated of known substances. Probably we can do better, however, than to go back to that particular starting point for a new departure. Meanwhile two questions of great interest will probably occupy the physicists for some time to come. One is, what property of matter permits any form of it to maintain a practically eternal energy in expelling a stream of fragments of its own mass? The other is, what is the form of matter thus projected? It has been assumed with some show of plausibility, as the result of calculations from the imperfect data now available, that the radiation of radium would in about ten thousand millions of years reduce the mass about 1 grain in weight for each square inch of surface. Obviously it cannot be projecting the atoms of the Dalton hypothesis. These units of the molecular groupings, however small, would exhaust it at a much more rapid rate than that assumed in the case of radium. The form of matter expelled must be infinite subdivisions of the mathematical unit called the atom; perhaps the primordial matter of the alchemists. The narrow door thus placed invitingly ajar may lead to truths of which the students of the middle ages had a clearer perception than those of modern times, who know more and dream less, and whose imaginations are hampered by the desire to prove all things. It may be we shall be no happier and no better off when we know why radium behaves in a fashion so extraordinary; but the world is full of wise men who cannot rest until they do know, and it may very well happen to them, as it has to others, that in searching for the end of the rainbow they will find a great many things they were not specially looking for which are of immediate and immeasurable utility. That we could not usefully employ radium if we had it in masses is probably due to reasons which have discouraged the search for the universal solvent—we have nothing to keep it in.—The Iron Age.

[Concluded from SUPPLEMENT No. 1426, page 22849.]

THE DEVELOPMENT OF MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.*

By EMILE GUARINI.

IN April, 1901, Marconi established communication between Biot in France (Fig. 30) and Calvi in Corsica (Fig. 31), the distance between these two points being

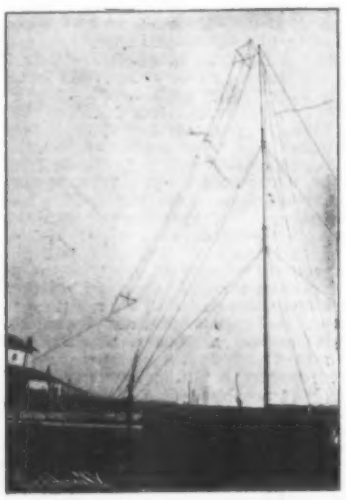


FIG. 30.—THE STATION AT BIOT (FRANCE) SHOWING THE FOUR-CABLE ANTENNA.

175 kilometers (108.7 miles). In these experiments antennæ were used having four cables suspended from masts respectively 52 meters (170.56 feet) and 54 meters (176.12 feet) in height. Fig. 32 represents the transmitting station; Fig. 33 the receiving station, and Fig. 34 pictures the complete equipment of one of the stations. In Fig. 34, the man seen in the middle to the left is the general director of the Marconi International Marine Company, to whom much of the success which has been obtained with wireless telegraphy in maritime communication is due. He has been an earnest advocate of the Guarini repeater.

At this place should be emphasized the great advantage obtained by connecting the secondary windings in parallel. It should also be remarked that Marconi, not content with inducing the oscillating current in the antennæ, induced it also in the transformer at high tension. This transformation at high tension is of value in operating the coherer, for the reasons already given. It ceases, however, to be of advantage because of its danger and likewise for the reasons which will be later given.

So far as the receiver is concerned, with the exception of the few details, it contained nothing new besides the "jigger." In the secondary winding of the induction coil of the "jigger," at its middle, a condenser is inserted, where two nodes of the tension are formed. By reason of this arrangement, the coherer (Fig. 35) was inserted between two loops of opposite signs for waves of the proper length, suitable transformers being employed. The calculations made by Captain Ferrié showed that a straight line drawn to the top of the antenna should have passed at 500 meters (1,640 feet) beneath the water (Fig. 36). During the course of the experiments which we have described, perturbations were observed, due to the atmospheric electricity and to telluric currents.

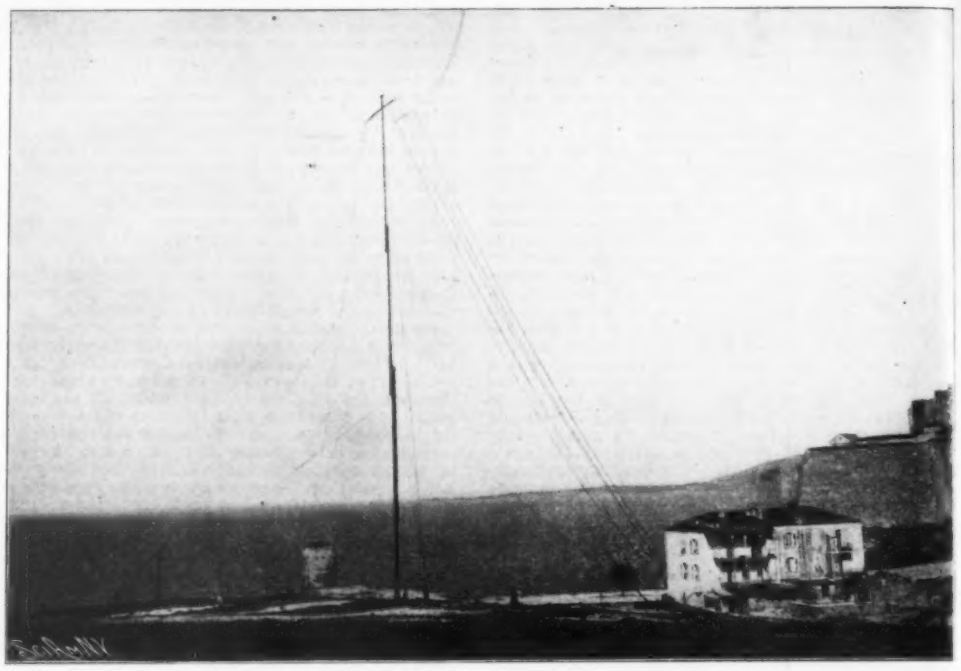
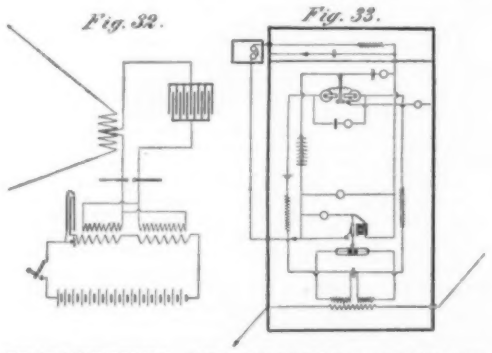


FIG. 31.—THE STATION AT CALVI (CORSICA), SHOWING THE FOUR-CABLE ANTENNA.



TRANSMITTING AND RECEIVING STATIONS.

Experiments were also made to ascertain the selective efficiency of Marconi's "jigger." The results clearly proved that it was possible to attune a receiver of that kind if it were not influenced by waves of a length very different from that for which attunement was established. But with the apparatus at Marconi's disposal it was not possible to realize double communication. One of the receivers, it is true, did record one of two telegrams, but the other recorded both of them or none.

I shall now discuss the transatlantic transmission of messages with which the world is more or less familiar, and which seems to have given the cable companies no little concern.

On December 12, 1901, Marconi received at St. Johns, Newfoundland, signals which had been sent from Cape Lizard. In February, 1902, he received dispatches on the "Philadelphia" when she was distant from Cape Lizard, the sending station, 1,555 miles. The signal "S" was received up to a distance of 2,000 miles.

The coherer, especially if its principle be not thoroughly understood, presents many a difficulty. Among its numerous defects there is one which it has been difficult to remedy—its sensitiveness is not constant, which is an imperfection due to the change of position of the filings by reason of the shocks to which they are subjected. The ideal receiver should be one in which the energy of the wave will directly influence a receiving apparatus. Recognizing this, Edison and Preece employed a telephone in their inductive telegraphs. In my own experiments, previously mentioned, described in the London Electrician, November 9, 1901, the Hertzian waves acted as a telephone. Since that time, Ruhmer has succeeded, by means of an apparatus somewhat similar to my own, in operating a telephone situated at a distance of 2 kilometers (1.2 miles), employing antennæ 30 meters (98.4 feet) in height and of a very moderate energy. In his magnetic detector (Fig. 37) Marconi also employs a telephone, but the waves of high tension serve only to produce variation in magnetic hysteresis of a magnetic core. The magnetic detector was used with great success on the "Carlo Alberto" during her voyages to Kronstadt and to Spezia. But besides the magnetic detector the coherer type of receiver was also employed. In transmitting messages from Poldhu to Cape Breton, as well as in his previous experiments in sending messages from Poldhu to the "Carlo Alberto" as she proceeded on her voyage from Spezia, and later from Cape Breton, antennæ were used having the form of an inverted pyramid and composed of many wires. Apart from its colossal proportions,

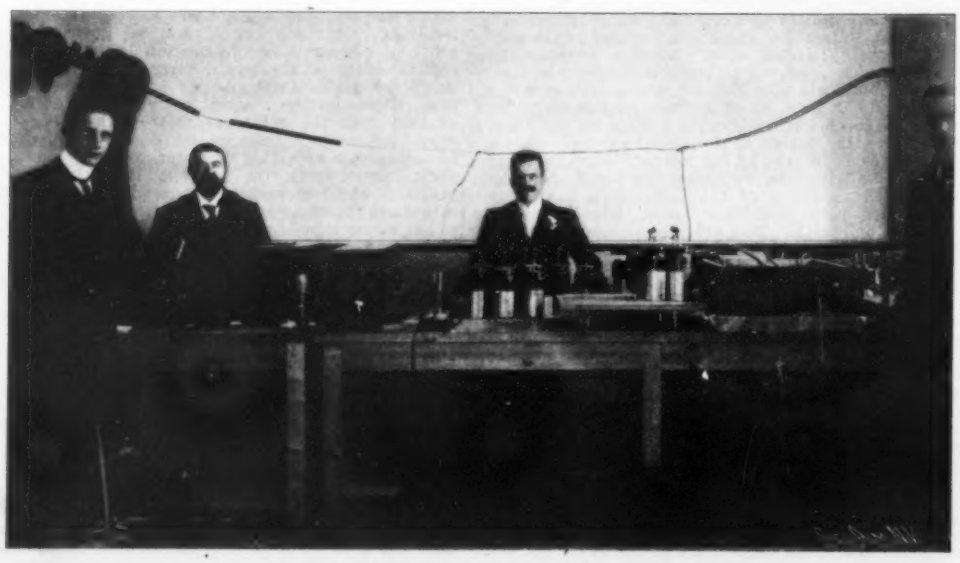


FIG. 34.—COMPLETE EQUIPMENT OF ONE OF THE CALVI-BIOT STATIONS.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

the antenna was similar to that which I used in my experiments between Brussels, Malines and Alvers (1900-1901).

In order that the improvements which Marconi has made may be better grasped, Fig. 37 may be of some service, illustrating as it does a complete Marconi station with detector, coherer, and receiver of the type used in the Biot-Calvi experiments, connected in parallel with the detector; a multiple-coil transmitter of the type used in the Biot-Calvi experiments; an antenna transformer, of the type used in the Channel experiments; and pyramidal antenna, composed of concentric cylinders.

Much has been said of an energy of 40 horse power which, it is rumored, was employed in the transatlantic experiments. Nothing would be apparently easier than to augment at will the energy used. As a matter of fact, the difficulty increases when it is considered that open circuits are employed in which the current is the product of the capacity by the frequency. The energy of the discharge is represented by $C V^2$. As it has been already remarked, the term V can be increased only to the point permitted by practice, but not the term C, since we should then augment the period of the wave.

$$T = 2\pi\sqrt{L C}$$

at the same time as we change the current flowing through the antenna, open circuit. On the other hand, in order to obtain with a difference of potential V a charge q, sufficient for the production of a disruptive charge of definite length, the coefficient (time, speed transmission) must be considered. From what we have said it follows that Marconi was compelled to content himself with a very limited speed of transmission if he used an average primary energy of 40 horse power or $736 \times 40 = 29{,}440$ watts.

An arrangement which seems full of promise is that which is represented in Fig. 39. The power is divided among several oscillators fitted with condensers, each closed circuit actuating a distinct antenna, or all the circuits influencing the same antenna, as indicated in the figure in question. It goes without saying that precaution should be taken in coupling the "alternators," found in the manner recommended by means of secondary windings of transformers; otherwise an oscillator, at any given moment, could send a passing wave at its positive semi-period, while another oscillator will, at the same instant, send through the same antenna a passing wave at its negative semi-period, thus producing a radiating effect equal to or almost equal to zero in value. By means of the arrangement illustrated in Fig. 39 a high frequency can be utilized, with a current of comparatively low tension, so that any desired energy can be obtained, thereby rendering it possible to send messages to any distance.

Before reviewing the commercial side of wireless telegraphy, I shall briefly discuss the manner in which waves are propagated in long distance communication, on which subject there is much diversity of opinion.

Fig. 35.

Fig. 36.

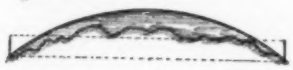


Fig. 41.

Fig. 42.

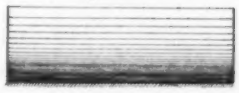


Fig. 43.

Fig. 39.

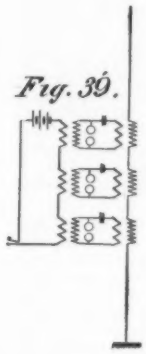


Fig. 38.

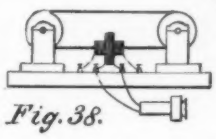


Fig. 37.

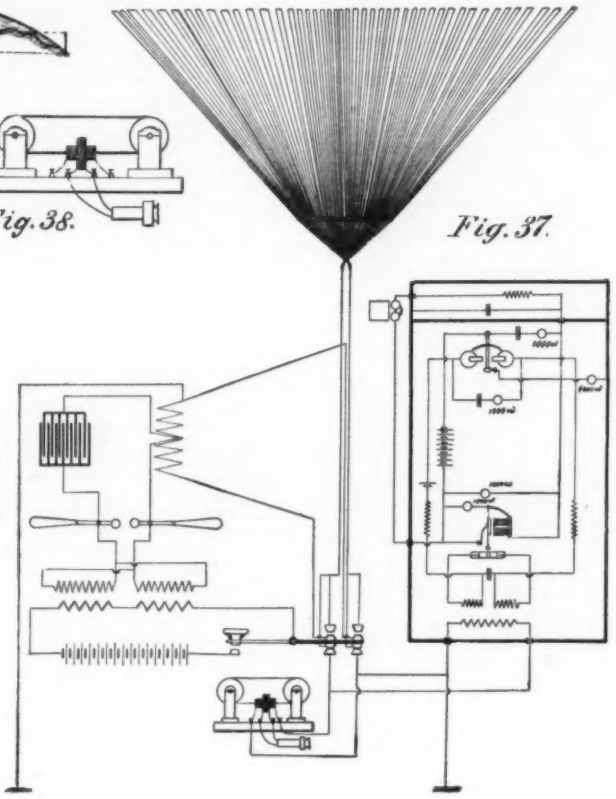


Fig. 44.

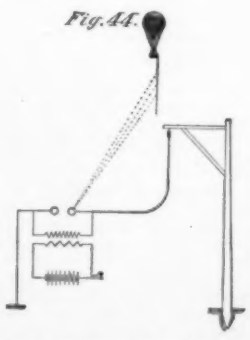
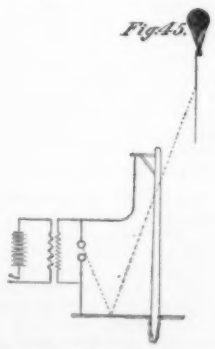


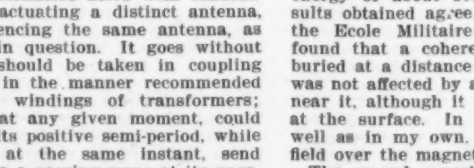
Fig. 45.



THE PROPAGATION OF HERTZIAN WAVES TO A BALLOON.

A French officer is of the opinion that the waves are propagated by the submarine cables which serve as intermediary antennæ (Fig. 40). An English scientist holds that the waves, during their journey, are several times reflected by the sea and by the conducting layer of rarefied air to be found in the upper regions of the atmosphere.

Fig. 40.



The function of the transatlantic antenna of Marconi can be explained in two ways.

According to Blondell the phenomenon of wave propagation is to be explained as follows: The layers of ether at the surface of the ground have a maximum electrical density (Fig. 41), and can be compared to a kind of electric mist rising to a height equal, at the most, to that of the transmitting antenna (Fig. 42). It follows that a receiving antenna will, in this case, be more influenced when it is entirely immersed in this mist (Fig. 42) than when it is only partially immersed (Fig. 43).

Ingenious as this hypothesis is, it is difficult to believe that it accurately describes the actual state of things. Experiments made by Capt. Ferrié and by Lecarme, show that it is possible to send a message from a terrestrial station to a balloon, floating more than a hundred yards above the antenna.

The phenomenon can be explained without any difficulty if it be admitted that the Hertzian waves are propagated like light waves. In this case the receiving antenna will be influenced directly from the oscillator or from the antenna (Fig. 44), or indirectly, that is to say, after reflection by the earth (Fig. 45). The lines of electric force are here considered.

Still other authorities hold that the waves are propagated by diffraction, increasing as the waves become longer. This hypothesis cannot be denied. But it should not be forgotten that in this case the waves must surmount an obstacle more than 186 miles in height—the curvature of the earth. So far as my own theories are concerned, a little experiment which I made convinces me that an electric field can traverse obstacles only with loss of energy (deviations and absorptions), while a magnetic field traverses the earth crust without serious difficulty and with moderate loss. The experiment is the following: Two pits were dug to a depth of about 2½ meters (8 feet). In these pits operators and instruments were hermetically sealed. The pits were separated by a thickness of earth of about 2 meters (6.56 feet), and were tightly closed by means of a metallic cover, upon which earth was heaped. It was first found that when a very short antenna was used in one of the pits (Fig. 46), the coherer, connected with a similar short antenna, was not affected, despite the fact that a transmitting energy of about 300 watts was employed. The results obtained agree with those of Prof. Lagrange of the Ecole Militaire de Belgique. Prof. Lagrange found that a coherer encased in a wooden box and buried at a distance of 60 centimeters (about 2 feet), was not affected by a very powerful oscillator situated near it, although it was affected at a certain distance at the surface. In Prof. Lagrange's experiments, as well as in my own, the predominance of the electric field over the magnetic was clearly established.

The second experiment which I conducted was as follows: In one pit a battery and an electromagnet were placed; in the other a magnetic needle (Fig. 47). The needle was influenced, although the transmitting energy used was simply a few watts. The effects observed in the pits were almost the same as those observed at the surface. I immediately drew my conclusions of the partial transparency of the earth to the magnetic field. I also succeeded in demonstrating in 1899 the propagation of waves through obstacles and through the earth's crust. In a monograph which I published, "Transmission de l'Energie Electrique par Fils et sans Fil," Liége, June, 1899, I made the following statement:

"What has just been said proves that the lines of electric force pass through obstacles, although their energy is partially absorbed during passage. Furthermore, it should be noted that a receiver, placed behind an obstacle, will be influenced, if the energy, after having been partially absorbed, is still sufficient to affect the coherer; that when a thick obstacle is located between the two stations, the necessary potential will be even larger and the maximum loss of transmission will always be less than when no obstacles intervene."

In a supplementary note I said: "The Revue des Revues publishes a communication from Tesla, who has just invented a new system of telegraphing with-

Fig. 46.

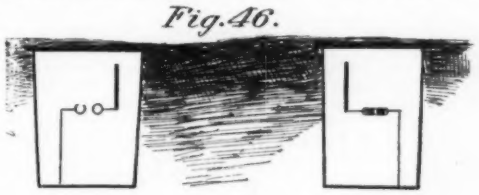


Fig. 47.

Fig. 48.

EXPERIMENTS WITH BURIED INSTRUMENTS.

out wires. In the transmitter, the radiations act like X-rays, passing through the most dense substances, the earth, stones, water, and the like. For the receiver, he employs apparatus (the principle of which we do not as yet know) by which it is possible enormously to increase the speed of transmission. May we hope by this means to establish communication by causing the electric rays to pass through the strata of the earth? That is impossible. By this means the problem of wireless telegraphy cannot be solved. As a matter of fact, the radiations are sent in all directions through space, where they are concentrated in a

definite direction. If radiations are sent in all directions, every receiver in the radius will be affected, and this it is absolutely necessary to prevent. If the radiations are conveyed in a definite direction, the pencil of rays will suffer such reflections that the rays will be dispersed in different directions, and it is even possible that, instead of assuming the proper direction, they will never reach the receiver. This may happen if the pencil of rays should encounter ores, which would offer an impassable barrier. In the one case, as well as in the other, wireless telegraphy through the earth cannot absolutely solve the problem."

Is it not possible to find in these statements some explanation of the phenomenon observed on board the "Carlo Alberto"? I refer in particular to the abrupt cessation in receiving messages, noticed at certain places, without any apparent cause, during the voyage to Kronstadt and back.

In 1900 Marconi informed me that he had taken the trouble to study my explanation. He declared that experience had shown quite clearly that it was not necessary, as I maintained, that the antennæ should be completely in sight of each other in order that messages might be received. To which I replied by saying that when the antennæ were in sight the effect was more marked, since there was no absorption of energy by the interposition of an obstacle.

Marconi had a vague intuition that a magnetic field passed through obstacles and through the earth, since in his English patent, June 27, 1896, describing apparatus consisting of antennæ and plates (that is to say, an apparatus in which electro-dynamic induction is possible) he speaks of an "arrangement permitting the transmission of signals through obstacles, such as hills and mountains."

In considering wireless telegraphy from the commercial standpoint, it is now well known to all that the Marconi system of wireless telegraphy has been practically applied in England, Italy, and Belgium, as well as on board merchant ships.

Certain objections, however, have been leveled at the commercial possibility of using wireless telegraphy. To attain secrecy is the great end. In order to assure secrecy in wireless telegraphy in its present state of development, it is proposed (1) to use a secret code and (2) to send the waves in definite directions and not in any other direction. But in this latter case, if, when the waves are sent in a definite direction, there happen to be a large number of stations in line, intelligible communication could not be attained, it is said, because the stations would influence each other. In solving this problem we must consider it from two aspects; (1) if the coherer be used and (2) if the magnetic detector be used.

If the coherer type of apparatus be used, we must differentiate (*a*) between communication among ships and (*b*) communication between fixed stations.

So far as ships are concerned, is syntonization really necessary? For long-distance communication, to be sure, there are many advantages. But is secrecy actually required? As a matter of fact, secrecy would be disastrous. If each vessel be differently attuned, from every other, communication between vessels, so important at sea in case of accident, would be impossible. It is indeed necessary that all should be able to communicate with one another. So far as communicating between fixed stations is concerned, it must be confessed that with every possible precaution, and with all the "jiggers" in the world, syntonization can never prevent interference and confusion of messages. Indeed, if the term *t* come into play and the several stations were to send signals of different durations, so that only stations having correspondingly timed signals could communicate with each other, still it would be impossible to avoid the superposition of signs.

If separate and distinct communication is to be established by means of the detector, apparatus being used similar to that employed in connection with the coherer, the difficulties to be overcome will be even greater. The silence preserved by Solari in his report on the subject, and his otherwise enthusiastic conclusions, are significant. The conclusion which is to be drawn from all this is that it is not necessary to limit the distance to which waves are sent and from which they are received, if absolute secrecy of communication is to be realized. At short distances the messages can be sent with more secrecy than with the ordinary telegraph and just as distinctly.

CONTEMPORARY ELECTRICAL SCIENCE.*

A NEW KIND OF LIGHT.—R. Blondlot makes an important communication on a new kind of radiation which he has discovered by its action on a very small electric spark. It is emitted by Röntgen ray tubes, but has properties entirely distinct from Röntgen or Becquerel rays, from cathode rays, ultra-violet light, or ordinary light. It penetrates aluminium, black paper, and wood like X-rays. Unlike these, the new rays are polarized when emitted, are subject to further rotary or elliptic polarization, and can be refracted, reflected, and diffused, but exert no photographic action and produce no fluorescence. The author obtained a rotation of 25 deg. or 30 deg. by means of a set of mica plates. The interposition of a mica plate having its axis at an angle of 45 deg. to the plane of action of the new rays destroys their original rectilinear polarization, for their subsequent action upon the small spark remains the same whatever be the azimuth of the plate. On interposing a second plate of mica normal to the first, or a Babinet compensator, the rectilinear polarization is re-established. Hence, there is true double refraction. "But," continues the author, "if double refraction exists, then, *a fortiori*, simple refraction must exist, and thus I was led to inquire whether, in spite of all the fruitless attempts to produce the refraction of X-rays, I could not obtain a deviation by a prism. I therefore made the following experiment: A focus tube sends through an aluminium screen a beam of rays defined by two vertical slits made in two parallel plates of lead 3 mm. thick. The small spark is placed on one side of the beam, so that it cannot be reached by it, or even by its penumbra; this is proved by the fact that the interposition of a lead plate produces no effect. Now let us interpose in the beam an equilateral quartz prism, with its refracting edge on the side opposite the spark. If the prism is suitably placed, the spark becomes much more brilliant. On removing the prism, the spark becomes feebler. This phenomenon is clearly due to a refraction, for if the orientation of the prism be changed, or if it be replaced by a quartz plate with parallel faces, no effect is observed. The experiment may also be made in a different manner: The beam is first allowed to fall upon the spark, and it is then deviated by the prism. The beam is then looked for by means of the spark, and is found to have been displaced toward the base of the prism, as in the case of ordinary light. Having proved the existence of refraction, I sought to concentrate the rays by means of a quartz lens. The experiment succeeds easily. One obtains the image of the anti-cathode, extremely well defined as regards size and distance by a greater brightness of the small spark." He also obtained geometrical reflection by producing a conjugate focus and reflecting that by means of a polished glass plate. Quartz has an index of refraction of 2 for some of the rays, at all events, but there is probably a whole spectrum of them, for the deviation by the prism is not sharp. The author has not yet determined the wave-length of the rays. On reducing the current which feeds the focus tube, the new rays persist long after the tube has become dark. An induction coil of a few millimeters spark-length suffices to furnish them.—R. Blondlot, Comptes Rendus, March 23, 1903.

PHOSPHORUS EMANATION.—A piece of phosphorus imparts electric conductivity to the air in which it evaporates. Other solids, such as sal-ammoniac, benzoic acid, and naphthalene, do not produce any conductivity, although they may produce a thick fog. G. C. Schmidt maintains that the conductivity is not due to an "emanation" of ions, but simply to the fact that the phosphorus fog contains a great number of oxidation products having a high conductivity. They acquire a charge during their formation, and then follow the lines of electric force. But this charge is only imparted to the particles by contact with one of the condenser plates providing the electric field. Whatever plate happens to be nearest, attracts the particles in the same manner in which a rubbed glass rod attracts a pith ball. That the visible cloud is the bearer of the conducting particles is proved by the fact that the conduction varies continuously with its aspect. There is no saturation current, and the relation between E.M.F. and current intensity is a linear one. The conductivity decreases as the heavier particles fall down to the ground. The author proves that they consist of various phosphoric acids. Sulphur oxidizing in air just below its point of ignition produces no conductivity, since it does not produce a fog of solid conducting particles.—G. C. Schmidt, Ann. der Physik., No. 4, 1903.

ELECTRIC PRODUCTION OF SLEEP.—Some months ago (see The Electrician, Vol. xlix., p. 660) S. Leduc described how, with 10 to 30 volts, and with currents interrupted 150 to 200 times per second, the inhibition of the cerebral hemispheres could be brought about in animals, thus producing sleep and a general anæsthesia. The procedure had the disadvantage of producing at first contractions and clonic convulsions, raising the pressure of the blood, provoking the evacuation of the bladder and the intestine, and momentarily stopping respiration. These disadvantages are largely reduced by introducing into the circuit an inductionless resistance allowing the operator to attain the necessary intensity gradually in three to five minutes. This method requires a preliminary introduction of the maximum E. M. F., but this should be put as low as possible. When the E. M. F. is then gradually raised to the necessary figure the animal passes gently and gradually, without a movement of defense or of flight, without a cry, and without any change in the movements of respiration or heart action, from the waking state into a quiet and regular sleep, with absolute anæsthesia. The dog at first bows its head as if sleepy, sits down, lies down on its side, and eventually goes to sleep without having given the least sign of fear or pain.—S. Leduc, Comptes Rendus, November 17, 1902.

WAVE TELEGRAPHY.—R. Blochmann describes a new system of wireless telegraphy which, while not possessing some advantages of the present systems, has certain attractions when small distances are concerned. He calls it "ray telegraphy." Its distinctive characteristic is that lenses are substituted for antennæ. The material of the lenses must have a high dielectric constant, and may consist of resin, glass, paraffin and the like. An important observation made is that the lenses, to be effective in concentrating the electromagnetic rays upon a distant object, need not be very large in comparison with the wave-length used. Thus, mirrors 80 centimeters in diameter suffice for waves 20 centimeters long, and signals can be exchanged over several miles. At the receiving station, a similar lens is used. In fact, the apparatus is practically a heliograph employing invisible instead of visible light. The dark rays have the advantage of being secret and of not being intercepted by fog or by non-conducting solids. Mountains are an obstacle, but this can be overcome by a series of relays. The direction of the arriving waves can be clearly distinguished to within a degree, and many simultaneous messages may thus be received and separated. Messages may also be sent out simultaneously in various directions.—R. Blochmann, Physikal. Zeitschr., November 1, 1902.

NERVE CURRENTS.—The most explicit theory of electric nerve currents is that of Hermann. It does not explain, however, why the "demarkation" current diminishes progressively with the time, eventually disappears, and sometimes develops into a slight current in the opposite direction. The surface of demarkation remains, therefore, limited in the nerve, because the traumatic alteration does not go further than the first strangling observed by Ranvier, and a new section immediately brings a strong current into prominence. In his experiments to demonstrate the indefatigable nature of the nerve, N. E. Wedensky prolonged tetanization for several hours, and showed that if the repose current is very feeble, the positive variation always replaces the negative variation. This also is not explained by Hermann's theory. The author has observed that the effects of narcosis can be produced not only by narcotics, but also by various chemical and physical agencies after they had acted for a certain time. The author designates by "parabiosis" the various conditions which produce this uniform change in the nerve. Parabiosis consists essentially in the complete temporary suppression of excitability and conductivity. The parabiotic current shows the negative variation under the influence of tetanization.—N. E. Wedensky, Comptes Rendus, November 10, 1902.

LOSS OF WEIGHT OF RADIO-ACTIVE SUBSTANCES.—A. Heydweiller has arrived at the extraordinary conclusion that the energy of radium rays is due to the conversion of gravitational potential energy into radio-activity. He finds that the loss of weight of a radio-active substance is much greater than was supposed by Becquerel, who thought it would lose about 1 milligramme in 1,000 million years. The author found that one of de Haen's "concentrated" radium preparations lost 1 milligramme in 50 days while inclosed in a sealed glass tube. The substance had a surface of 20 sq. cm. If it gave off the same energy as Becquerel's radium preparation, it would yield 100 million ergs per day, or about 100 ergs per second. The loss of weight observed per day is 0.02 milligramme. Now, the author points out that the potential energy of that amount of matter in the earth's gravitational field is 120 million ergs. The two amounts of energy are strikingly similar. On the one hand, the substance loses potential energy at the rate of 120 million ergs per day. This amount is recovered to the extent of 100 million ergs per day in the form of radio-active energy. The electrons emitted have, according to Kaufmann, no gravitational potential energy in themselves. If they had it while within the substance, the chain of argument identifying the loss of weight with the expenditure of energy would be complete. The author does not, however, mention all these considerations, but vaguely refers to Kelvin's vortex ring theory of atoms.—A. Heydweiller, Physikal. Zeitschr., October 15, 1902.

CHEMICAL EFFECTS OF CANAL RAYS.—Cathode rays are known to have a strong reducing effect. It may be supposed that the negative electron saturates a positive valency of the metallic atom. This, therefore, acquires a lower valency than before, and can no longer bind as many atoms of the halogen. It was to be expected that canal rays, consisting as they do of positive ions associated in some way with neutral atoms, would exert an oxidizing action. G. C. Schmidt has undertaken some researches to test this supposition. He finds that there is no well-defined oxidizing action. There is powerful decomposition, but it depends upon the nature of the gas and the compound whether the decomposition results in an oxidation or a reduction. Solid solutions which show luminescence under cathode rays show the same under canal rays, but it decreases rapidly owing to decomposition, which is indicated by the spectrum of the glow becoming whitish. If the gas in the tube is oxygen, and an oxidizable body is in it, the latter is oxidized. If, on the other hand, the gas is hydrogen, the latter reduces any compound capable of reduction. The most typical reaction for canal rays is the decomposition of sodium compounds. It takes place even when only traces of sodium are present, and is revealed by the D-line.—G. C. Schmidt, Ann. der Physik., No. 11, 1902.

CONTACT DIFFERENCES OF POTENTIAL.—A novel method of determining contact potentials between metals has been devised, theoretically at least, by P. Boley. It is based upon the E. M. F. of a special class of cell. The saturated amalgams of the two metals, M and M′, under consideration are associated with two suitable electrolytes L and L′. In the chain: M amalgam—liquid L—liquid L′—M′ amalgam, the total difference of potential E is the sum of the differences at the various junctions, and if the contact E.M.F. L|L′ is negligible, we have

$$M'|M = E - M|L - L'|M'.$$

To make L|L′ negligible, L may be made a normal solution of H_2SO_4 with an addition of MSO_4 in centi-normal dilution, and L′ a normal solution of H_2SO_4 with a centi-normal addition of $M'SO_4$. If the metallic sulphite is nearly insoluble, the solution may be saturated with it. The observations are made with an electrometer by the compensation method. The author has provisionally applied the method to determine the contact difference of potential between silver and lead. The chain is: silver amalgam|normal H_2SO_4 with mercurous sulphate in excess mercury. In this case E is 0.002 volts, M|L 0.926 volts, L|M′ — 0.925 volts, and hence M′|M = 0.001 volts. This value lies below the limit of experimental error. The method must, therefore, be rendered more sensitive.—P. Boley, Comptes Rendus, September 15, 1902.

CONDUCTIVITY OF PRESSED POWDERS.—F. Streintz has continued his researches on the conductivity of powders, and examined the conductivities of metallic oxides and sulphides under pressures equal to those which gave a quasi-metallic coherence to platinum black and other substances. He observed, as a general rule, that compounds having a light color, such as white, yellow, red, or gray, conducted badly, and that most dark powders conducted well. This is as it should be according to the electromagnetic theory of light. On the other hand, a number of powders of a dark color are non-conductors. The great difficulty was to obtain the powders in such a condition as to transmit pressure equally in all directions, and careful grinding had to be resorted to, especially in the case of crystals. No pressed powders were discovered which could be classed both among metals and among electrolytes. In fact, truly electrolytic conduction was not found in any powder. Only such powders were conductors at the ordinary temperature as could be brought to a state of metallic luster and hardness without the use of a binding medium. Such bodies possess a positive temperature coefficient. There is for all these compounds a temperature of transition from a low to a high conductivity. If any oxide or

* Compiled by E. E. Fournier d'Albe in the Electrician.

sulphide is a good conductor the next higher oxide or sulphide is a still better conductor.—F. Streintz, Ann. der Physik., No. 12, 1902.

ZEEMAN EFFECT.—A. Faerber has endeavored to reduce Runge and Paschen's magnetic separation of spectrum lines to absolute measure. The researches of Preston, Blythswood and Merchant, Reese, and Kent show divergences of 3 per cent in the value of $\Delta\lambda/\lambda$ ^{2}H for homologous lines which, according to Lorentz, should be constant. The source of light employed was the spark of a large induction coil which crossed between the poles of an electromagnet parallel to the lines of force. On one of the poles a strip of zinc was mounted, and on the other a strip of cadmium, insulated by a plate of mica, so that both the zinc and cadmium lines could be obtained simultaneously on the same photograph. The field was measured by means of a bismuth coil. The results show that the separation of the spectrum lines is proportional to the field. Whether this proportionality applies to very strong fields is doubtful, since the strongest field did not exceed 24,000 units. The work of Kent and Reese makes it probable that it does not. The value 18.13 for $\Delta\lambda/\lambda$ ^{2}H with regard to the lines 4,678 and 4,680 is probably correct within 1 per cent, and is most likely the most accurate value yet found. It gives a new and accurate measure for the strength of a magnetic field.—A. Faerber, Ann. der Physik., No. 12, 1902.

DEMONSTRATION OF ELECTRIC OSCILLATIONS.—L. Zehnder describes some simple lecture arrangements to demonstrate the experiments of Feddersen, Paalzow, Hertz, and Lecher. Feddersen's condenser discharges may be shown by means of a simple rotating mirror. A cylinder of dry wood or ebonite has a mirror inserted in a depression. In front of this mirror, and with its axis parallel to that of the cylinder, is placed the spark-gap of the condenser, and in front of that, again, a lens which projects the spark upon a translucent screen. The revolution of the cylinder makes contact and discharges the condenser at the instant the image is projected by the mirror through the lens on to the screen. Paalzow's experiments are demonstrated by means of a vacuum tube 62 centimeters long and 3.5 centimeters wide placed next the poles of a horseshoe magnet separated by 12 centimeters. With a small spark-gap in the condenser circuit or without any spark-gap a simply bent spark is obtained, and with a large spark-gap the other phenomena described by Paalzow, such as a double bending, corresponding to discharges in both directions. The successive discharges are separated by the heating of the air in the spark-gap, which drives the discharges upward and separates them in a vertical plane.—L. Zehnder, Ann. der Physik., No. 12, 1902.

LOSS OF RADIO-ACTIVITY.—A body "activated" by a radium compound loses half its radio-activity in the open air in about half an hour. The interior of a closed vessel similarly activated loses half its radio-activity in about four days, the delay being due to the presence of radio-active air inside. But if there was a vacuum originally in the vessel, or if the active air is replaced by fresh air, the loss of radio-activity takes place at the same rate as in the open air. P. Curie has examined the rate of loss of a vacuum tube by inserting it in the inner cylinder of a cylindrical aluminium condenser. The rays from the radio-active walls penetrate the inner cylinder, activate the air between the armatures, and discharge the condenser, the rate of discharge being a measure of the activity of the tube. The law of loss of radio-activity is very simple. It is expressed by $I = I_0\, e^{-\frac{t}{\theta}}$, where I_0 is the initial activity, t the time elapsed and θ a certain constant representing another time. The author has verified this law in an experiment lasting 20 days, in the course of which the radio-activity diminished 27 times. The mean value for θ is 5,752 days. This constant appears to be of great importance, since the author has found it to be the same under the greatest variety of experimental conditions.—P. Curie, Comptes Rendus, November 17, 1902.

COLOR PHOTOGRAPHY.

FROM the earliest days of photography, efforts have been made to reproduce by it alone the colors of nature. It was found as long ago as 1801 by Ritter, of Jena, that the various rays of the spectrum differed considerably in their action on silver chloride and in 1810 Seebeck, also of Jena, obtained a reproduction of the spectrum in some approach to natural colors, on paper coated with silver chloride. These images could not, however, be fixed.

Various other experimenters have from time to time endeavored to obtain the desired result by the use of different materials and methods but without effecting a complete solution of the problem.

In 1891 Lippman laid the foundation of the process known by his name, it being based on the theory of Zenker and work of Wiener with due acknowledgment to both. This is distinguished as an "interference" process, the effect being produced by decomposition of the light.

The apparatus employed for the production of the picture is very simple, differing but little from that used for ordinary photography. Any transparent sensitive film answers as the photographic surface. This film is exposed in a camera of the usual type with the difference in arrangement that the plate is backed by a layer of mercury, which layer, of course, acts as a mirror. The arrangement is effected by using a slide so arranged that mercury can be allowed to flow into a space back of the plate after the plate has been placed in the slide. After exposure the mercury is allowed to flow out and the plate is then developed in the usual way.

The materials on the finished plate are the same as those on an ordinary negative, but a difference exists in the structure of the deposit, by which it is enabled to decompose the light by which it is illuminated and reflect those portions of it which correspond to the natural colors of the object from which the picture was taken.

The reason for the formation of this structure as formulated by Lippman is that the light waves as they rush through a plate, as ordinarily arranged, impress the plate more or less strongly and thus leave a design of different intensities of the image but in this rapid passage they leave no record of their own forms. Each ray of light of a certain color has a certain structure; it is made up of waves which have a certain wave length. If there be a mirror behind the plate, the light, says Lippman, is reflected back on itself, the light rushes in and rushes out again with the same velocity; the entering and issuing rays interfere and the effect of the interference is that vibration takes place; but the effects of propagation are stopped, and instead of having propagated waves we get stationary waves; that is, the waves now rise and fall, each in its own place; they pause therefore in the interior of the film and impress their form upon it.

On looking *through* a film obtained by the Lippman method, it appears like an ordinary negative; its color effect is obtained only when viewed by *reflected* light, different portions of the plate reflecting different colors according to the light waves by which it had been impressed. In order that the interference colors may be seen so that they are true to nature the plate must be viewed by vertical incidence, which is inconvenient. They may be projected by an arrangement devised for the purpose.

In 1861 Prof. Maxwell showed at a lecture at the Royal Institution that by taking photographs of a colored ribbon through three solutions colored to represent the primary colors and then projecting these photographs so that their images were superposed, a colored image of the ribbon was given, which was faulty however from lack of photographic materials more sensitive to the less refrangible rays. In 1873 Prof. Vogel announced that dyes would influence the distribution of color-sensitiveness in plates.

On these facts are based the process of Ives, brought out in 1892. In his process, three negatives are obtained through color filters; from these positive transparencies are made (in monotone), which are placed in a special viewing instrument called the "kromskop," each in combination with its properly adjusted color screen; these being then combined, the images are seen in the original colors of nature.

The next development in this method was the introduction of the process worked out by Prof. Joly in 1894. This differs considerably from the Ives method in the manner of working, but in principle it is very similar. Only one negative, instead of three, is required, but this is taken through a transparent lined screen, ruled very finely and closely with parallel alternate lines of orange, yellowish-green, and blue. After development, a positive transparency is made from the negative, which, when mounted accurately and in close contact with a viewing screen similarly ruled with parallel lines of red, green and violet, the image is seen in its original colors. These mounted positives are usually viewed as lantern slides, but are somewhat marred by the obtrusiveness of the lines, when seen too closely.

To go back to the underlying principle of the three-color process—the "filtering" out of certain rays in taking the different plates—we should explain that the primary colors from which white light is formed are now set down as a particular shade of red, a particular green and a particular blue-violet. The primary pigmentary colors it may be added are red, yellow and blue, as has always been taught. If we obtain three negatives from an object each taken through a color filter or screen adjusted for the red, the green and the blue-violet respectively, these plates will present negative images of the object in the negative values of the colors named. When from each of these negatives we produce a positive in the complementary color, and combine these positives in accurate registration, we shall, if the operations have been correctly performed, obtain a reproduction of the original object in the exact colors of nature. The ordinary photographic plate as is well known is not sensitive to all the rays. If, however, the addition of certain colored substances, chiefly anilin compounds, be made to the emulsion, these apparently combine with the haloid silver salt to form an organic compound of silver, which is sensitive to the light reflected from various colors, according to the particular dye employed; and in this way it is possible to obtain a plate which will be sensitive to the light reflected from all the colors of the spectrum, though for convenience in working the extreme red is generally excluded, or otherwise the plate could only be made and handled in complete darkness.

The processes of Lumière and others are essentially the same as that of Ives, varying in the details of working.

From a recent article in the British and Colonial Druggist which has furnished us epitomes of some of the facts above noted we take now the substance of some details of the working of the three-color process.

The negatives are taken through color screens of red, green, and blue-violet, adjusted for use with the Cadett spectrum plate. By means of a repeating back used in connection with a frame containing the screens, these may all be taken upon one plate; that is, when the size of the picture required is small, such as is suitable for a lantern slide. The length of exposure varies with each of the screens, an ordinary ratio being, say, 55, 13, 4 for the red, green, and blue-violet respectively; but on account of unavoidable variations in different batches of emulsion, largely due to the difficulty in obtaining gelatin of uniform quality, these ratio exposures are liable to differ, but can be readjusted without great difficulty by making a trial exposure upon some subject with well marked high lights and half-tones, such as a crumpled piece of white blotting-paper, which should appear equal in all three negatives. The length of the exposure through the red screen may be gaged by a fraction tint actinometer, by timing to a certain tint; from the time thus obtained the remaining two exposures can then be calculated from the ratio numbers.

A special form of camera is mentioned in which the exposure for the three negatives can be made simultaneously by means of mirrors.

The plate must be developed either in darkness or by a special "safe" light supplied for use with such a plate, and a developer of the rapid type used, yielding a soft negative of good gradation without stain. Correctness of exposure is essential, forcing development being almost certain to result in failure. Intensification and reduction can only be effected at great risk of interfering with the gradation of the image, and should never be resorted to unless it is impossible to make another exposure. The best intensifying reagent is said to be mercuric iodide with sodium sulphite.

"The next step," says the author, "is the production from the negatives of the three positives, and first we produce a blue, or rather greenish blue, positive from the negative obtained through the red color filter. This, in the Sanger-Shepherd process, is done by first making a lantern slide positive in the ordinary way by contact, taking care to secure one of good quality and well representing all the detail and gradation in the negative clear and free from fog, for the density and detail of the finished slide will largely depend upon the blue positive. This, after fixing and washing, is treated with a solution of potassium ferricyanide, again well washed, then immersed in a solution of a ferric salt, rinsed and replaced in the fixing solution, and finally again washed to free from hyposulphite. The effect of this is to convert the deposit of silver into one of Prussian blue. When dry this plate should be varnished, preferably with a solution of celluloid.

"The remaining two positives, the pink and the yellow, are produced by a modification of the carbon process. A celluloid film, coated with an emulsion of silver bromide in soft and soluble gelatin is employed. This is sensitized by immersion in a solution of potassium or ammonium bichromate, and when dry printed in contact with the two other negatives, care being taken to place the celluloid side next the film side of the negative. The necessary exposure varies from one to 10 minutes according to the light, and should be gaged by means of the fraction tint actinometer. The silver bromide takes no part in the formation of the image, its functions being to afford some guide in the exposure and development by giving a faintly visible image, and to assist in the more rapid disintegration of the gelatin in the warm water used for the development. The water used should be of a temperature of from 90 deg. to 100 deg. F., as in the carbon process, and when all the soluble portions which have not been acted upon by light are removed, the silver bromide is dissolved out by a solution of hyposulphite, leaving the almost invisible photographic image in relief in clear gelatin. The positive thus obtained from the negative taken through the green filter is then immersed in a dye-bath of a pinkish-red color, and that from the negative taken from the blue-violet filter in one of a yellow color, and they are stained to the required depth, comparing the result by holding in approximate position occasionally with the blue positive without touching each other. I find that it is usually better to overstain these positives and then wash down in water to the required depth of color.

"The blue positive may be obtained in similar manner upon a thin celluloid support, using a weak solution of methylene blue as the stain, and this method is preferred by some workers. The advantage, however, I think, rests with the prussiate process, in that a positive is produced of maximum sharpness, being printed in actual contact, without the necessity for the interposition of the celluloid, this being more essential in the case of the blue print, which, as before mentioned, forms the foundation of the finished slide, for, however slight the diffusion may be, it must necessarily be more apparent if it exists in each of the three monochromes."

In the method of working recommended by Messrs. Lumière the three stained positives are produced upon a mica support. The mica has the great advantage of rigidity, but the still greater disadvantage (in my hands) of frequently failing to retain the gelatin film, which I have known to float off, even in the bichromate sensitizing solution.

"The pink and yellow positives having been dried, are placed in register with the blue, and any preponderance, or inequality in coloring noted. This can be corrected by careful reduction in cold water of either the pink or yellow films. The greens are usually the best guide, as if these are correct the other colors will usually be found to follow. If the blue be at fault it will be found better to make another rather than attempt to alter it. When finally adjusted and dry, the two celluloid films are varnished with a special transparency varnish, in order to prevent the colors from running. The three positives may now be placed in accurate register and bound up with a cover glass as usual, but the transparency and unity of the complete positive will be much improved by mounting in Canada balsam. This is effected by first fixing the two celluloid positives on one edge of the blue plate, by trimming first the pink, so that when it is in register there is a margin of at least one-eighth of an inch of the blue extending beyond it, then the yellow, so that the pink extends beyond it for the same distance. The three can then be fixed down by a piece of lantern binding strip, or better and more securely by a thin strip of paper, firmly fastened down with fish glue, as I find the gum of the binder does not always adhere securely to the celluloid. The three positives and the cover glass are then made warm, the Canada balsam, thinned by heating in a beaker, poured in a sufficient quantity between each of the positives and also under the cover glass, the excess pressed out; the whole is then placed between strong spring clips till set, after which the slide can be cleaned with alcohol and masked and bound up as usual. Should any separation or bubbles occur, these may generally be remedied by again warming the slide and replacing it in the clips for a few hours."

The three-color process has assumed much importance as a means of producing colored prints. To do this the process is modified to produce three half-tone plates, the negatives being taken through filters of the complementary colors and from these the prints are made by the use of suitable inks, the impressions being made accurately one over the other. Here the primary colors are represented by pigments of red, yellow and blue (as before noted) and the colors overlapping and mingling produce, approximately at least, the various tints required.

The method by which half-tone plates are obtained

was described in the Circular for March, page 62.

It has been recently reported that Prof. A. B. Leckenby has devised a new method of color photography, the details of which have not yet been made known. The method is said to be the same as the old system of photography up to the making of the print. The difference lies in the emulsion on the sensitive paper. The slight differences in the shades on the negative plate are just enough to act in different ways on the paper during printing and produce the several colors. One fault has been found with the pictures; they are not all the same shade. A red rose may show pink at one time, and with the next toning and fixing a dark crimson. In either case the color will still be red, but the shades will be decidedly different. Even this objection, which is not in itself very serious, Dr. Leckenby thinks will be remedied, and he has, he says, worked out a method which will have the effect of bringing the various prints to a more even tone.—Druggists Circular.

HENEQUEN—THE SISAL FIBER OF YUCATAN.*

By E. H. THOMPSON, U. S. Consul at Progreso, Mexico.

IN ancient times the agave, or henequen,† was one of the most important plants of the peninsula.

At a time when most of Europe was in the pall of utter darkness, when the "Parisii" lived in caves and the Gauls in "wattled huts," the priests and rulers of Yucatan lived in stone temples and palaces. Up the steep sides of the myriad pyramids were carried great blocks and sculptured columns.

To move these mighty masses of limestone no powerful engines were at hand, but the Batabs of Yucatan, like the rulers of ancient Egypt, had little use for mechanical devices. Human muscle and ropes of agave (henequen) were all-sufficient. If ten ropes and a hundred slaves were not enough, a hundred ropes and a thousand slaves were not lacking. The ancient artists made use of the fiber in their work. They were not content to make the figure; they made the skeleton, and upon the bones and in the flesh, like the cords and muscles of the body, they placed cords and plaited bands of fiber. Close examination indicates that the fiber used was that of the yaxci plant. Over the imbedded muscles and flesh they placed a thin, hard wash of stucco to represent the skin and surface pigments. The writer has examined many dozen specimens of the broken figures of stucco wherein are plainly shown the casts and the knots and braid, even the very character of the fiber.

The primeval inhabitants probably did not at first attempt to extract the fiber from the thick pulp, but took the leaf and wilted it in the fire, then split it, and used the splits as thongs. The leaves so treated make thongs of great strength, and as they dry they bind with wonderful force. In the primitive forms of habitation in the region, the mud and wattle "nás" are bound together by these shreds of fiber-wilted leaves. They are shapely, water-tight, and durable, and the native builder's only tool is a heavy, sharp-edged knife. Not a spike or nail or metal of any kind enters into the building.

Later the people found that if they cleaned off the thick pulp and the green corrosive juice they could get a firmer hold and so bind tighter. Then they learned to twist the shreds, and this idea led to the making of ropes and cords.

Toward the end of the eighteenth century, when there happened to be a scarcity of hemp for the cordage of the Royal Spanish Navy, search was made for a new material to eke out the supply from Manila. Some one told of the fiber used by the Campeche people in Yucatan. A royal commission was ordered to investigate, and its report, made in 1783, gave unstinted praise to the fiber.

For a few years quite a little henequen was sent to Europe. Then with the collapse of Spanish commerce the demand for it ceased and for half a century its existence seems to have been forgotten by the world.

Meanwhile the people of Yucatan grew poorer and poorer until, in their desperation as to how to get money to buy the necessities of life, some bright merchants thought of the fibrous plant which fifty years before had had commercial value. An association was formed and they began to experiment with the plant. A quantity of fiber was rudely cleaned by native instruments, and, packed in loose bales of about 200 pounds each, was sent to New York. It found a market, but the price was such that there was but scant gain for the seller. The methods of cleaning the fiber were so slow that even with the small wages of the day, the cost per pound to the planter was discouraging. The state government, recognizing the great need of a suitable machine to clean the fiber, offered a gratuity of $10,000 Mexican to the person inventing an apparatus capable of producing a stated output per hour. This finally resulted in the "raspador," the device of a Franciscan friar, which was used for many years.

The raspador marked a new era for the commerce of Yucatan. With the aid of this machine, two men could clean in one day more than forty could with the tonkas and pacché. Its use became extended, and henequen farms began to multiply and become prosperous. To-day, half a dozen machines are in the market, some of them marvels of design and potency.

The natives of the interior, however, still use the ancient, triangular, sharp-edged piece of wood called the pacché. An able-bodied person can clean with the instrument from 6 to 9 pounds of fiber a day. The fiber obtained thus possesses qualities which that cleaned by machines does not have. In the hammock-making districts of Yucatan the leaf is cleaned in the ancient method (see illustration on this page), and the makers of the finest hammocks, those worth their weight in silver, will not use a fiber produced by any other method.

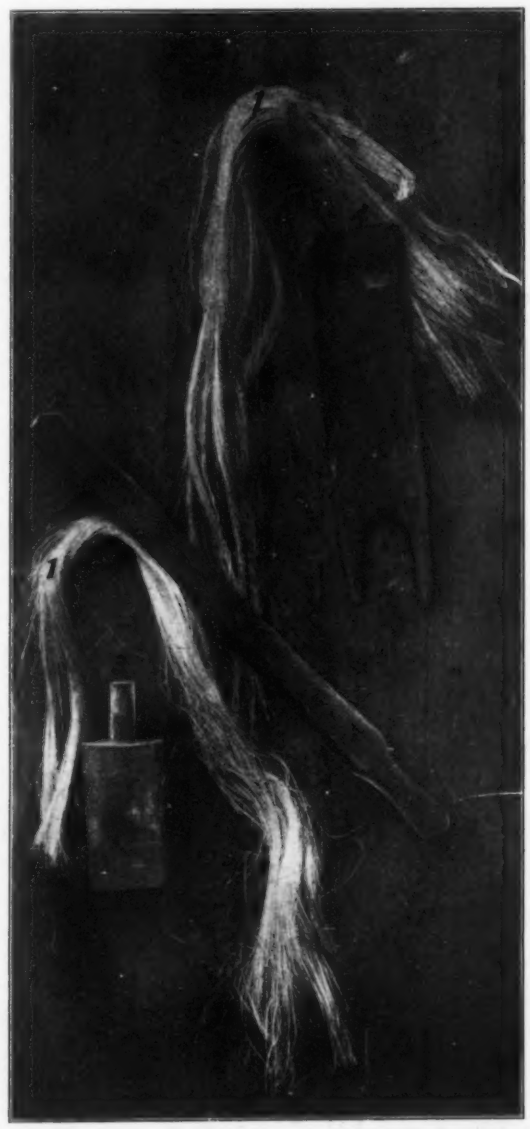
THE AGAVE PLANT.

The agave is one of the most characteristic plants of Mexico. One of the family, the *Agave americana*, produces the pulque, the intoxicating drink of the country. Great fields are covered with this plant upon the Mexican tableland, and long "pulque trains," like the milk trains of the United States, roll daily into Mexico city.

This beverage is practically unknown to the inhabitants of Yucatan, and the variety that produces it is to be seen only as an exotic in the gardens and parks. Its place is taken by another member of the family, whose importance is more far-reaching. The *Agave sisalensis* furnishes a fiber that not only helps to knit firmer the commerce of the whole world, but binds the sheaves of wheat so that the price of bread in every land is made cheaper for its use.

From photographs by E. H. Thompson.

A NATIVE IN THE INTERIOR CLEANING THE FIBER BY THE ANCIENT METHOD.



1. TRESSES OF THE SISAL FIBER CLEANED BY THE PACCHÉ. 2. PACCHÉ. 3 AND 4. NATIVE IMPLEMENTS FOR CLEANING FIBER.

To the casual observer a field of the pulque plant and one of the fiber plant are very similar in appearance. Both show the same peculiar green, the same many-thorned leaves, but a nearer view soon shows the difference.

There are three known varieties of the species growing wild in the forests of Yucatan—the chelem, the cahum, and the citamci—and I think that I have found a fourth wild variety during my explorations in the interior. There are also two varieties of the cultivated plant—the yaxci or green fiber, and the sacci or white fiber. The last-named plant is the more cultivated and the one producing the sisal hemp, or henequen, of commerce.

CULTIVATION.

A thin, rocky limestone soil is generally supposed to be the best for the growth of the sacci plant. Experience indicates that the fiber grown upon this class of soil has a percentage of tensile strength greater than that produced on the richer lands, though the latter is more flexible and is longer. The percentage of safety allowed by the cordage-makers is so high that I doubt if the diminished tensile strength of the rich-land hemp would seriously affect the quality of the output. Contrary to the general idea, a poor sandy soil is not congenial to the growth of a large, full-

* For the illustrations we are indebted to the National Geographic Magazine.

† The fiber is often called Sisal grass or Sisal hemp, though it is neither a grass nor a hemp. The name "Sisal" was applied to it because it originally reached the outer world through the port of that name.

sized fiber plant. Few, if any, good-sized, well-formed plants grow very near the coast line. The best Yucatan fiber plant seems to be produced in a zone or belt following the coast, about 12 miles away from it and 70 miles wide.

The plant can be propagated in various ways—by seeds, by cuttings, and by scions or suckers. The first-mentioned method is now never undertaken. Very few of the abundant seeds are fertile, and the time lost in raising the seedlings is great. The second method—by cuttings—is frequently undertaken; the top of an old, nearly worn-out plant is taken just before the long pole that should bear the flowers shoots up. It is cut off and trimmed of all save the newest leaves, and then planted in the ground as though it were a scion. These plants are said to produce earlier than others.

The general method, however, of producing a field of the sisal plant is as follows: A field is cut and the refuse burned; then a month or so before the rainy season the "hijos," or scions of sisal, that have sprouted under the shelter of the parent plant, are rooted out of the ground when they get to be 18 or 20 inches high, and thrown in a heap. There they lie for two or three months exposed to the sun and the weather. Just before the rainy season, when they seem to be dried up and decayed, they are carried to the cleared fields and planted in rows. Formerly they so planted the young plants that they were separated by spaces of barely 2 yards, but of late years it has been found best to space them so that they will be in lines, each plant separated from the one preceding it by a space of 1½ yards and the lines 4 yards apart (about 1,100 plants to the acre). Thus, long and wide lanes are formed between the rows that facilitate cutting and carriage of the leaves, and also lessen the wounding of the leaves by the spines and thorns of their neighbors.

Previous to 1889 but little attempt was made to grade the hemp. Yaxci, sacci, short staple, long staple—all went as "sisal." Now, a fine, white fiber, well cleaned and baled, can command a notably better price than mixed fiber, ill-cleaned and badly baled.

The hope of the future is in the careful selection of hemp plants. Many plantations, more by good fortune than otherwise, are stocked with fiber-producing plants of a high order; others are handicapped by plants producing a meager fiber. The quality of the soil in both cases seems to be the same; the difference is in the class of plants. This phase is a comparatively new

A FIELD OF YOUNG SISAL PLANTS—TWO YEARS OLD.

DRYING SISAL FIBER AT ONE OF THE LARGE PLANTATIONS—YUCATAN.

one on the plantations of Yucatan fiber and has only recently been taken into serious consideration.

The scion when planted ("anchored" would perhaps be the better word, as it is more often held by heavy stones than by the earth around it) needs no special care or irrigation. Once or twice a season the fields are roughly weeded. The plant thrives, and generally in about five years the earlier leaves commence to extend themselves laterally at right angles to the trunk of the plant. This is nature's signal that the fiber has reached its highest point of tensile strength and that the leaves are ready to be cut. The native cutters then throng the field, and with their corbas deftly cut the leaves close to the trunk, trim off each line of side thorns at a single stroke, snip off the horny end, and bind up the leaves in bundles. Tram cars take these bundles and carry them to the cleaning machine.

THE ENEMIES OF THE PLANT.

Fire is its greatest enemy. Hot seasons do not affect it. In fact, the heat of the sun, especially when accompanied by dampness, seems to act as a tonic. It is then, if ever, that the plant recovers from its injuries. The greatest heat experienced in Yucatan for the last ten years was in July, 1900, when the thermometer reached 119 deg. F. in the half shade of a veranda; 147 deg. F. has been experienced in the sun on the principal street of Merida. Long droughts may delay its development, and by wilting the mature leaves cause them to double and injure the fiber, but it cannot stop the ultimate growth of the healthy plant, once it is well rooted. Rainy seasons do not seriously affect the plants, except those in stagnant water. This weakens the plant, but this condition is not common. Cold seasons of the kind that Yucatan experiences do not seriously affect the plant. The coldest known period was in February, 1899, when the thermometer registered 47 deg. F.

But fire conquers it. Let a spark from a locomotive, the lighted end of a cigarette, or the embers of a fire made to heat the bread of the native workers start the flames in an ill-cleaned field, and nothing but a miracle can save the crop from total loss. It is said that some planters in the past have taken advantage of the susceptibility of the plant to artificial heat, and when the plant that is such a valuable product of their country made common.

Next to fire, a large, long-nosed black beetle is the greatest enemy of the cultivated sisal. It is known to the natives as the "max." Dr. Gaumer, an American physician residing in Yucatan, whose studies and writings upon the fauna and flora of Yucatan have made his name familiar to naturalists everywhere, at my request writes of the insect:

"The female insect lays its eggs on the trunk of the henequen plant a few inches above the ground. When young plants were desired for export, they were doctored before delivery by having their roots heated over heated embers or dipped into boiling water. The effects of this treatment are not perceptible for a time, and possibly this fact may make clear to some enthusiastic foreign planter why his scions, purchased with so much care and expense, never grew and prospered. Naturally, the Mexicans do not desire to have hatched the larva burrows into and through the outer bark to the harder fiber of the interior, when it generally takes an upward direction and burrows from 6 to 12 inches during its larval existence. When full grown it works its way to the bark, where it changes to a pupa and so remains for some months, when it hatches into the adult beetle and emerges from the plant, which it leaves injured and weakened, but rarely kills. Three or more larvæ in the same plant will surely destroy it, but that number is of very rare occurrence."

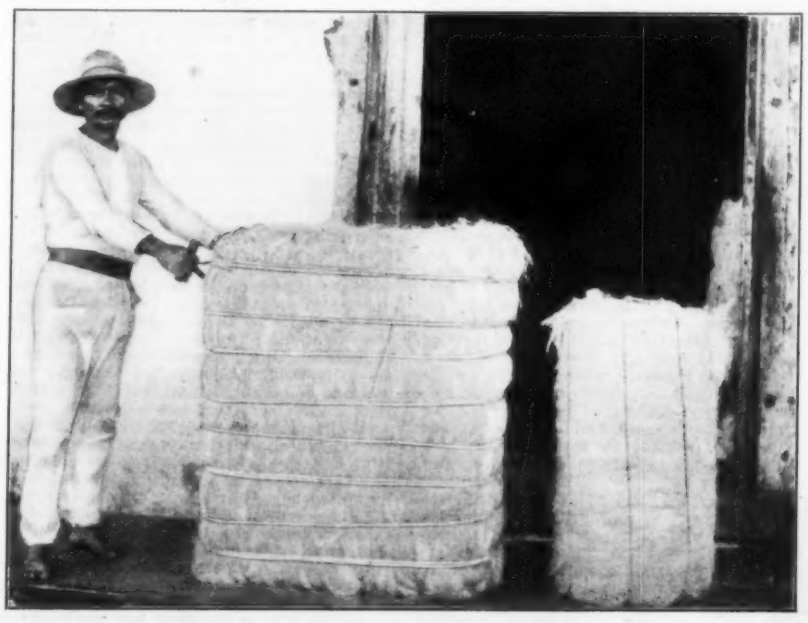
The life of the plant can be greatly prolonged. I have seen fields old at ten years, and others vigorous and hearty at nineteeen years. The plants should be originally healthy scions, the leaves must be cut at just the right time, and the long pole must be nipped off before it has become more than a mere protuberance. Once the pole has grown, the plant ages rapidly.

VALUE OF HENEQUEN.

The export of henequen is making Yucatan one of the richest states of Mexico. In 1902 the states sent out nearly six hundred thousand bales, or ninety thousand tons, worth $14,000,000. Most of it went to the United States, where it is used for sacking, cordage, and binders' twine.

There will be a falling off in the supply for the season of 1903. The causes of this diminishing output, despite the high prices that prevail, will be the decreasing acreage of new fields. Laborers are scarce, and the great majority of planters dislike to stop cleaning fiber long enough to plant new fields or replant old ones.

Production of an Elastic Leather Varnish.—According to G. L. Mohr of Darmstadt, a mixture, moistened with nitric acid, of ferric chloride, green vitriol, yellow and red prussiate of potash, is sharply dried, mixed with good linseed oil, and heated with admixture of tallow, which has turned sour under the action of damp air, whereupon the varnish is allowed to settle after addition of siccative, gloss-oil, and linseed oil varnish.—Neueste Erfindungen und Erfahrungen.



BALES OF SISAL FIBER READY FOR SHIPMENT.

REPORT ON A VISIT TO AMERICA.

By Lieut.-Col. H. A. YORKE, R. E., Chief Inspecting Officer of Railways.—Board of Trade, London.

I.—STEAM RAILROADS.

CONSTRUCTION.—There is a fundamental difference between the modes of construction of English and American railways. In England the bull-headed rail resting in cast-iron chairs is almost universally adopted for lines of heavy traffic. In America the T-rail or (as it is sometimes called in England) Vignoles rail is invariably employed, the rail being secured to the sleepers or ties by means of ordinary spikes. The Americans claim that their permanent way is easier and quicker to lay, cheaper to maintain, smoother to run over, and as durable as the English type. As regards weight of rails there is not much difference between the two countries, the American engineers having now adopted 100-pound rails, with a base 6 inches wide, as their standard for heavy lines, as against rails of 80 pounds and 85 pounds which were formerly employed. Of course there are in the States many lines with rails lighter than any of the above, but I am now referring only to the more important lines, on which heavy rails are found to be necessary. In England the weight of rails for main lines now varies from 85 to 103 pounds, e. g., those used by the London & North-Western Railway Company weigh from 90 to 103 pounds; by the Great Western Railway Company from 92 to 97½ pounds; by the Great Northern Railway Company 92 pounds; and by the London & South-Western Railway Company 85 pounds. The English railway chair weighs from 40 to 54 pounds.

In America the number of sleepers or ties is greater than in England, but the difference between the practice of the two countries is not so great as is sometimes supposed. In America the average number of ties employed with heavy rails is 14 or 16 to a 30-foot length of rail, and 18 with light rails of the same length. In England the number of sleepers used is 12 to a 30-foot length of heavy rail. The average dimensions of an American tie are, 8 feet long, 8 inches wide, and 7 inches deep. For a 30-foot length of rail with 14 ties this gives a bearing area as between the ties and ballast of 74.6 square feet, and with 16 ties, 85.3 square feet.

The dimensions of an English sleeper are: 9 feet long, 10 inches wide, and 5 inches deep. This gives a bearing area for the same length of track of 90 square feet. The advantage in this respect is therefore with the English practice.

Again as regards the bearing area of the rails on the ties, the American method with 14 ties gives 14 by 6 inches by 8 inches = 672 square inches for one 30-foot rail, or with 16 ties, 768 square inches. The English chair for heavy rails has a base of 105 square inches, so that 12 of these give a total area of 12 by 105, or 1,260 square inches. Here again the advantage is with the English method.

It must, however, be noted that the American ties are of hard wood, such as oak or chestnut, and are therefore better able to resist the pressure of the rails than the English sleepers of Baltic timber.

The lateral support afforded to the rails by the English chair is of the greatest value, especially on curves, and in America the absence of chairs renders it necessary to use rail braces, which are of the nature of small steel brackets or struts, to support the rails at any place, such as a curve or switch, where there is much lateral pressure. It is also usual in many places to employ bearing plates, or tie plates, between the rails and the ties so as to increase the bearing of the rail on the tie and to afford mutual support to the spikes. The effect of these tie plates however is to shear off the heads of the spikes. The fact that these additions are found to be necessary, shows that the American mode of construction is lacking in certain elements to stability which are inherent in the English type of permanent way.

The Americans do not place their rail joints opposite each other as we do in England, and there is a good deal to be said in favor of the American practice in this respect. The joint is admittedly the weakest part of the permanent way both vertically and laterally, and it can hardly be doubted that it is an advantage to make the rails break joint, so that the weak spot on one side of the track shall be supported by the continuous rail on the other side.

Perhaps the detail most open to criticism in the American permanent way is the use of spikes, in the place of screws or fang bolts, to fasten the rails to the ties. These are constantly working loose, and then have to be driven home again. When this process has been often repeated, the holding power of the spikes must be diminished. But with hard wood ties this defect is not so serious as it would be with the soft wood sleepers used in England. In fact hard wood seems to be essential for the American style of permanent way. If this be so, there would probably be no economy in England in adopting American practice, for the extra cost of the ties would more than balance any saving due to the omission of chairs. The American road would, I consider, be vastly improved, if some form of fang bolt with rail clips were used instead of spikes, for fastening the rails to the ties.

As to the cost of maintenance, I cannot help thinking that the English method must give the best results, but many factors, such as the difference in the prices of labor and materials, and in the nature of the traffic, have to be taken into account.

The ballasting of the heavy lines in America, so far as I saw them, is as good as anything to be found in England, and there is no doubt that as a rule railway traveling in America is smooth and quiet, a feature which, though partly due to the road, may be also partly attributable to the invariable use of long and heavy bogie coaches.

Signaling.—Signaling in America is in an inchoate condition, there being no uniformity of practice throughout the country. Some portions of the principal railroads are fully signaled, but on many others hardly any signals are used, and even where signals are used, their shapes, colors, and meanings vary upon different lines. Signals are divided into various classes in a manner unknown in England, such as automatic signals, interlocking signals, telegraph block signals, train order signals, etc. Similarly with block working, only about 25,000 miles out of a total mileage (measured as single track) of 200,000 are at present worked in America on the block system, but its use is being gradually extended. Block working, however, is not so strictly interpreted as it is in England; two or more trains are constantly permitted to be in the same section at the same time, and trains are allowed under certain conditions to travel in either direction on either track, even where the lines are doubled or quadrupled. On two occasions it occurred to the train in which I was traveling, to be switched across from the proper track to the wrong track, without any halt, and without any formalities other than the handing to the driver or conductor of a train order, giving him instructions to travel on the wrong track, regardless of opposing trains. On both occasions we traveled in this way for several miles at a high rate of speed, there being of course no signals for the guidance or control of the train. Such a mode of working must be dangerous, as the least misunderstanding between the men who give and receive the train order, or any negligence on their part must lead to an accident.

Single lines, which form the bulk of the railroads of America, are operated almost entirely on the "train order" system, no train staff or tablet being used as in England, there being no less than thirteen standard forms of "train orders" in use. The train order system was tried in England, and has long ago been abandoned as troublesome and dangerous, and I believe that the American train service would be probably conducted with greater punctuality and economy and certainly with greater safety, if the electric staff or tablet system were introduced on the single lines.

For some time past American railroads have been using automatic signaling, about which a great deal has been recently said in England. The main (four track) lines of the Pennsylvania Railroad between New York and Pittsburg are signaled in this fashion, and so are parts of several other railways. The New York Central Company are also about to adopt it in the neighborhood of New York, and its use will doubtless extend. Recently in England the London & South-Western Railway Company have equipped a section of their line between Grateley and Andover with automatic signals, and preparations are also being made on the North-Eastern Railway for testing this mode of signaling.

The most modern and satisfactory mode of applying the system is by means of a "track circuit." A low tension current flows from a battery along one rail of the track through a relay, and back to the battery along the second rail. The relay makes and breaks a local circuit, which by means of electro-magnets controls the mechanism, electric or pneumatic or whatever it may be, for operating the signals. When the current is flowing along the line the relay completes the local circuit, and signal is held "off." When, however, an engine or vehicle with metal wheels and axles is in the section a short circuit is established in the track circuit, the relay becomes inoperative, the local circuit is broken, and the signal returns to danger. By insulating the rail joints at intervals, the line is divided into sections, to each of which a separate current is supplied, and signals are placed at the commencement of each section, by means of which the driver of an approaching train is informed whether the section ahead is clear or not. It must be borne in mind that a fundamental difference exists between "manual" signals, and "automatic" signals, in that the former have human agency and human intelligence behind them, and convey a direct order to a driver as to what he is to do, whereas the latter merely tell him the line is clear for a short distance ahead.

In America the sections for this system of signaling vary in length from about 700 yards to 1,300 yards, the average being 1,000 yards. As at the commencement of each section two signals (a home and a distant) are erected for each line of rails, signals become exceedingly numerous, and whereas the signals on American railroads have hitherto been too few, there is now a risk of their becoming too many. Block working, at any rate in England, means the maintenance of an adequate interval of space between two trains traveling on the same track. Goods trains of great length are now coming into use, and they are not infrequently as much as 800 yards long. With trains of such dimensions the interval of space between two trains may, if block sections are only 1,000 yards long, be as small as 200 yards, which, except at very low speeds, cannot be regarded as adequate. Again, the number of block sections into which a line requires to be divided depends on the number of trains which it is desired to pass over it in a given time. With block sections of 1,000 yards, and trains running at 60 miles an hour, the interval of time, or, as the Americans call it, the "headway" between them may be only 34 seconds, which is clearly impracticable and dangerous. Even at a speed of 20 miles an hour the headway may be only 1 minute 42 seconds, and at 10 miles an hour, 3 minutes 24 seconds, and as it can only occur at starting points or at terminal stations that it is necessary for trains to follow each other at such brief intervals as these, it is difficult to see the advantage of such very short sections in other parts of a line, where trains have to travel at speed, and where fast trains are mixed up with slow. Signals placed at such short distances apart are more likely to be confusing than helpful to drivers, whose confidence when running at speed must also be lessened by the shortness of the block sections. The only reason that I have been able to discover for the introduction of such short block sections, is that "track circuits" do not work well on sections of greater length, but it is difficult to believe that this defect cannot be remedied.

A difficulty arises in England in connection with such signals, and that is how to deal with them in time of fog. In America fogs are said to be rare—at any rate no special precautions are taken to meet such an emergency. But here it will be as necessary to provide means for "fogging" automatic signals as any other signals. Men for the purpose will be difficult to find, and if mechanical means are adopted for the purpose, the complication and weight of the signals will be increased, and the mechanism will be more liable to fail. The effect of climate and of weather upon automatic signals in England has yet to be ascertained, and it must be remembered that a signal which fails at any time to give a correct indication is likely to be a source of danger. Probably the greatest risks are to be anticipated from snow, frost, and lightning, any one of which may, under certain conditions, cause a signal to remain at "all right," when it ought to be at "danger." Should that happen, a most serious condition of affairs would exist, the results of which might be disastrous. Even under normal conditions the reliability of automatic signals depends on the most careful and trustworthy maintenance. In America, it is said, that the failures as a rule, result in a signal remaining at "danger," when it ought to be at safety, and as this would be likely to cause delay to the traffic, drivers are instructed, when they find such a signal at danger, to bring their trains to a stand, and then to proceed forward at caution, without waiting for the signal to be lowered. This rule may be unavoidable, but it is easy to see that sooner or later it must result in two trains being in the same section at one and the same time, which defeats the whole object of block working. Telephonic communication is usually provided, telephones being placed on every second or third signal post, so that in case of a breakdown, the trainmen can communicate with the nearest signal box.

In England the problem is further complicated by the existence of numerous industrial sidings on the main lines, the points and signals of which must necessarily be interlocked with the automatic signals, and require human agency to operate them.

There is something attractive about the term "automatic signaling," and the conclusion is sometimes hastily arrived at, that its adoption will immediately effect increased safety, greater economy and simplicity of operation, a reduction of expenses, and larger dividends. But the cost of installing a system of automatic signaling is great, involving as it does the erection of a power plant, electric or pneumatic, to supply the power for operating the signals, the laying of pipes, conduits, or cables for the entire length of the line for conveying the power to the signals, the provision of numerous wires, batteries, and relays for controlling the power, and the erection of a great number of signals, and the bridges or posts supporting them. Moreover, if the system is to take the place of an existing installation of manual signals, it is to be remembered that the whole of the latter has to be "scrapped." A considerable advantage, such as a large saving of wages, and a largely increased capacity of the railway must therefore be assured, in order to justify the outlay.

Automatic signaling does not of itself introduce greater safety of operation. It is merely a labor-saving device. No doubt it eliminates the risks due to mistakes of signalmen, but it introduces other risks peculiar to itself, due either to inefficient maintenance, to failure of the mechanism, to weather, and to accidents of various sorts. Moreover, the chief object of a system of automatic signaling must be to enable more trains to pass over a given section of the line in a given time, and more trains under such conditions necessarily involve increased chances of accident.

From what has been said it will be seen that the whole question of automatic signaling requires to be further considered before its applicability to main lines in England can be thoroughly ascertained, and the results of the trials of the system upon the London and South-Western and North-Eastern Railways, will be of the greatest value in the investigation of the subject.

But in "tubes," subways, tunnels, and especially on electrically operated railways, on which speeds are uniform, junctions and sidings are few and far between, sections short, and which are self-contained, automatic signaling will undoubtedly prove exceedingly useful, and some of the railways in London now being equipped for electric traction are to be signaled in this fashion.

Power Working of Points and Signals.—The application of some form of power, pneumatic or electric, to the operation of points and signals, is becoming a common feature in America at places where large signal cabins are necessary. Such installations possess many advantages, reducing the physical labor to a minimum, and rendering it possible to employ fewer men. They also economize space and abolish all rods and wires from the station yards. The chief, if not the only, objection to them is their cost, which in the first instance is much greater than that of an ordinary manual plant, and it is simply a matter of calculation whether at any particular place the economies to be derived from such an apparatus balance the initial cost. There are two systems in general use, viz., the electro-pneumatic and the low pressure pneumatic. In the former the movement of the points or signals is effected by air at 75 pounds pressure, which is admitted to cylinders containing pistons connected to the switches (or signals) by means of valves which are controlled by electric currents. In the latter the mechanism is operated by air at 15 pounds pressure, the valves being controlled by a secondary air supply at 7 pounds pressure. In England a large installation of a similar nature has lately been erected by the London & North-Western Railway at Crewe in which the motive power, as well as the controlling agency, is electricity. The North-Eastern Railway and Lancashire & Yorkshire Railway Companies are at the same time about to test the electro-pneumatic system, and the London & South-Western Railway Company are trying the low-pressure air method. It will therefore soon be possible to compare the results obtained by these three systems.

Rolling Stock.—Probably the feature of American railways which at first sight makes the most impression on a stranger is the colossal size of the engines and cars employed thereon, and to this is due much of the correspondence which at intervals fills the columns of the papers concerning American methods of handling traffic. There is no doubt that the engines are very big, some of them standing 16 feet high above rail level, and many more of them 14 feet 6 inches and 15 feet. Such engines have great power and are able to haul trains of great weight and length. In the early days of American railroads over-bridges and tunnels were almost unknown, and now that such are being constructed, they have to accommodate themselves to the rolling stock, instead of the rolling stock to the bridges, as in England. In America over-bridges are built 18 feet above rail level, whereas in England

the height of such works is as a rule only 14 feet, 3 inches above the rails. Moreover, on double lines in the States the space between the tracks is 7 feet, against 6 feet in England. It can therefore be understood that what is possible in the one country is impossible in the other, and we can never hope in England to equal America in the size of our engines or cars.

A great deal has recently been said about the long freight cars used in America, and English railway managers have been criticised for not adopting cars of equal dimensions in this country. I think some misapprehension occasionally arises on the subject. The important factor in the case is not the length of the car, but the carrying capacity of the car in relation to its weight. American freight cars are all carried on bogies, and as a rule there are eight wheels to a car. Their carrying capacity varies from 30 to 50 tons, and their "tare" weight from 15 to 20 tons. One of the most popular forms of car at the present time appears to be the 50-foot steel framed car with a capacity of 50 tons (of 2,000 pounds) and a tare of about 20 tons, the total weight per axle being 17 tons 10 hundredweight. So long as these proportions are adhered to it makes no difference, so far as the cost of transportation is concerned whether the load is carried in one car with eight wheels or in two cars with four wheels each. That is to say, the results will be the same if, instead of one car of the size and weight mentioned, two cars are employed, each with a capacity of 25 tons and a tare of 10 tons, and each having four wheels. Not all the cars in America offer such favorable conditions as those just mentioned. The box cars have as a rule a carrying capacity of 30 to 40 tons and a tare of 16 to 18 tons; the paying load in these cases having a less proportion to the dead load than is the case with the 50 ton cars.

There are serious difficulties in the way of introducing for general service in England wagons of great length. The sidings, goods sheds, weigh bridges, turntables, coal tips, screens, etc., are as a rule quite unsuitable for wagons of the dimensions named, to say nothing of the usual conditions of trade which are based on the present style of vehicle. It is sometimes suggested that English companies should forthwith reconstruct the whole of these works and appliances, but no one has as yet estimated what the cost of such alterations would amount to. It is probably incalculable, and the question arises, whether after all this vast expenditure had been incurred and the whole trade of the country had been disorganized during the transition period, the saving in handling the traffic would pay the interest on the outlay.

The four-wheeled wagon will therefore in all probability remain the standard wagon of the country, and economy is to be sought in improving the design of such wagons and increasing their carrying capacity in relation to their tare, rather than in introducing wagons of greater length.

There is no reason why this should not be done; in fact it has already been accomplished on some railways. Both the London & North-Western Railway and the Great Western Railway Companies have lately built four-wheeled wagons, having a capacity of 20 tons, and a tare of about 8 tons, which gives the same proportion of paying load to dead load, as an American car of 50 tons capacity.

Another argument against the employment of very long cars or wagons is, that in the case of a derailment or collision the results would be more serious, and the removal of the wreckage would be a much more difficult operation than at present.

There is also the difficulty to be considered due to the private ownership of the bulk of the wagons used upon English railways. This, though serious, need not perhaps be regarded as insuperable, as if the railway companies throughout the Kingdom were unanimous in adopting wagons of a new design, means could be found, perhaps with the assistance of the legislature, either to abolish privately owned wagons, or else to compel the owners thereof to adopt whatever type of wagon was found to be beneficial to the trade of the country.

It is not suggested that long wagons will never be used, as it is evident that for some purposes such wagons are desirable or even necessary. But for ordinary trade purposes in this country the four-wheeled wagon, of improved design and increased capacity is, I believe, the best suited.

The wheels of American cars, both passenger and freight, are smaller than those used in England, being only 33 inches in diameter, instead of 36 inches as in England. It seems worth consideration, whether 33-inch wheels might not with advantage be introduced in England for goods wagons. This would enable an additional depth of 3 inches to be given to the wagons, thereby increasing their capacity without adding to their height, and would at the same time lessen their weight, and effect some economy in their first cost. All the wheels of American freight cars, and occasionally also of passenger cars, are of cast iron with chilled rims. They are not turned in a lathe or machined in any way, but are used just as they come from the foundry. When the wheels are worn out, the manufacturing company takes them back at a fixed price, breaks them up, and recasts them. The net cost of such wheels to the railway company is, therefore, very small. Recently fractures of these cast iron wheels have increased in number, and it is a question whether, as at present made, they are suitable for the increased loads put upon them by the introduction of heavy cars. Improved modes of manufacture may overcome this defect, or wheels with cast iron centers and steel tires or wheels wholly of steel, may become necessary.

Couplings.—The law of the American Congress relating to the use of automatic couplings and air brakes on all freight trains engaged in interstate commerce came into full force on August 1, 1900, and the fifteenth annual report of the Interstate Commerce Commission, published in 1902, is a highly interesting document. From this it appears that the coupling mechanism is still far from perfect, especially in regard to the uncoupling attachments. Another "common defect in couplers, and one which is the cause of much trouble and expense to the railroads, is the breakage of the 'knuckle.'" The commissioners are evidently not satisfied with the couplers as at present used, for the report says, "it will be seen that the needs of the future, in respect to couplers, may be described under the heads of strength, simplicity, and finish."

Air-brakes.—The same report contains some severe criticisms on "the present condition of the air-brakes on the freight cars of the country, the lack of thorough training and discipline of the men in charge of trains, and the insufficiency of the forces assigned to inspection and repair"; the result being that "some companies, more particularly in the East, are still controlling trains on steep descending grades by the use of the hand brakes." This is in accordance with what I saw on the Pennsylvania Railroad, where numerous heavy coal and goods trains were being taken down the Horse Shoe incline by means of the hand brakes, the brakesmen having, in consequence, to run about on the roofs of the cars while the trains were in motion, a practice which is highly dangerous and a fruitful cause of accident to the trainmen. One reason assigned for this non-use of the air-brake on such inclines is that the driver may by repeated application and release of the brakes exhaust all the air in the air reservoirs. It then becomes necessary for him to re-charge them, and the doing so releases all the brakes, during which time the train may gain a dangerous degree of speed, and get beyond control. To overcome this difficulty "retaining valves" have been introduced for partially controlling the air pressure in the brake cylinders during the process of re-charging the reservoirs. These retain a pressure of 15 pounds in the cylinders during the time that the reservoirs are being recharged, and are described in the report already alluded to as "a device for more efficiently and safely controlling the speed of trains on steep descending grades." "While under favorable conditions the air-brake is efficient without this auxiliary, its use is a valuable additional safeguard, and on very steep grades it is a necessity."

Unfortunately the handles for operating these retaining valves are on the roofs of the cars, so that their use still renders it necessary for the trainmen to be above. As the number of bridges over the railroads is increasing, the danger to the men on the tops of high cars becomes greater, and a primitive arrangement for their protection is a common feature on American railroads. This consists of a rope supported on posts and stretched across the tracks on either side of an overbridge. From this rope depend short vertical lengths of thinner rope at close intervals, their lower ends being about the level of the underside of the bridge. The idea is that a man on the top of a high car would be struck by one of these ropes, and warned of the neighborhood of the bridge in time to avoid the danger.

The law does not render it obligatory on the companies to use the air-brake on all the cars of a freight train, but only on so many as will enable the driver to have sufficient brake power at his disposal for controlling the train down the inclines. This partial use of the air-brake is a cause of accidents, for when the brake is brought into operation on some of the cars of a train, the cars not so braked are by their momentum forced against those that are braked, with such violence as to crush, and sometimes derail one or more cars. The law in this respect seems to require amendment. If the air-brake is to be used at all on freight trains, it should be operative on every car.

From the above facts it will be seen that the problem of safely working heavy American freight trains down steep grades by means of the air-brake has not yet been entirely solved. And when it is remembered that some of the large American engines require three men on the foot-plate, viz., driver, fireman, and assistant fireman, and that the train crew consists of a conductor and two, three or four brakesmen, it may be questioned whether the economies claimed for the American methods are as great as is sometimes hastily assumed.

Grade Crossings.—It is interesting to note that American railroads are imitating English practice in one respect, and that is in the abolition of level or grade crossings. Enormous sums of money are now being spent with this object. This is specially the case on the Pennsylvania Railroad, on which line some very large works, such as viaducts, bridges, and deviation lines are in progress for the purpose of raising the tracks above streets and roads, and for improving grades and curves. These works are being paid for out of revenue and not charged to capital. The guiding principle followed in America on this much-debated question is, I was told, as follows: When a new work, however large, does not tap new sources of revenue, and does not serve a fresh area, but merely improves existing conditions and facilities, the cost is charged to income. When, on the other hand, new districts are reached, and fresh sources of traffic developed, the cost is charged to capital. To what extent the cost of works, such as those I saw in progress, amounting as they do in many places to a complete realinement and reconstruction of the railway, can be legitimately regarded as a charge against income I cannot say, but it is not surprising that the shareholders should grumble at being called upon to make such sacrifices for the benefit of those who will succeed them. I heard one argument advanced, which, if not openly avowed, may have an occasional influence on American railway finance, viz., that as American railways were built almost entirely with money raised on bonds or debentures, and that the ordinary stock, to a large extent, merely represents "paper," there is no obligation on those controlling the line to do more than pay the interest on the bonds and debentures, and that the ordinary stockholders have little or no moral claim to consideration.

Railway Service.—In the mode of selection of men for employment upon railways, and in the opportunities for advancement offered to them, the American railways are ahead of English companies. The following information on this matter was given to me by one of the chief railway officers in the States.

"Applicants for employment must be of sound health, free from physical, mental, or moral infirmities, and must produce satisfactory evidence of previous record, character, and ability. Employes are selected from applicants whose character, intelligence, physical capacity, and general appearance indicate that their services will be efficient and satisfactory, and who are likely to develop ability sufficient to merit advancement in the service.

"All employes are regarded as in the line of promotion, and examinations for promotion are held from time to time as may be required.

"Applicants who fail on the first examination must within one year make written application for re-examination. Those who fail on the second examination will be dropped from the service.

"Flagmen, brakesmen, and firemen who do not apply for examination within five years may be dropped from the service.

"The object of fixing a limit of five years to the term of service of a flagman, brakesman, or fireman is that these occupations are considered as preparatory training for the positions of conductor and engineman, which are the fixed types of employment in the transportation service; and a person who has not the capacity to qualify for either of these positions after five years' service is not likely to do so at any time, and should make way for those who are more capable and progressive."

In this way it happens that every man employed upon an American railway has the road open to him to rise to the highest positions, and many of the most prominent men in the railway world have so risen.

(To be continued.)

CONCRETE FLOORS AND WALKS.

THE use of cement and the manner of mixing it are not as well understood by the people generally as they should be. Cement walks, cellar or stable floors are better than those made of stone, brick or wood, and any handy man can make them. The first requisites for the work are good sharp sand and the very best grade of Portland cement. If it is a walk you wish to construct, first dig a trench a foot deep, just as wide and long as you want your walk. Next fill this trench with coarse sand or gravel eight inches deep, but if you have neither you may use coal cinders, packing down whatever is used with a maul or heavy block of wood with a handle fixed to it. Next place smooth straight boards four inches wide along the sides of this trench, fastening them with stakes. Place boards four inches wide across your walk, three feet apart, and you have your mold ready for first layer of cement. Have a strong tight mortar box and into this put sand and cement, four parts of the former to one of the latter. Mix this thoroughly while dry, then apply water with a sprinkling can, mixing all the while till you have a stiff mortar that you can handle with a shovel. Dump the mortar into your molds and tramp down 3½ inches thick, filling four or five molds at a time. Next take fine sifted sand and cement, equal parts, then apply water and make a soft mortar and spread this on top of the coarse cement, one-half inch thick, or to the top of boards, and level it off by drawing a straight edge over the frame. Then trowel it down and leave it for a few days to dry. Before the troweling is done, remove the partition boards and fill up level. This kind of a walk can be made at a cost of four cents per square foot if you do your own work and have gravel at hand. If all material has to be bought and laborers are employed to do the work, it will cost from eight to ten cents per foot. Cellar floors are made in the same way, but if the bottom is dry two or three inches of sand will be sufficient to lay the cement on. For stable floors or driveways, the cement should be five or six inches thick to insure durability.

Gate posts are made by digging a pit in the ground as large as wanted for post, and then a box mold is made, same size as post, and two feet high. Fill in first with stone pounded up about the size of a man's fist, and then make a mortar of three parts sand and one part cement, about the consistency of cream, and pour this into the form. As soon as this sets, move mold up and fill again till the post is of the desired height. When dry give it a coat of cement all around. This can be checked off into squares to resemble square stonework.

Another use of cement is in making water tanks for live stock. Make the bottom just as you would a walk only have it heavier and on solid foundation, also put in necessary pipes for filling and draining so frost will not injure. Next make a form on this foundation with boards the length and width desired for the tank. Inside of this set up another form ten inches smaller than the first at the bottom, sloping to six inches at the top. This will give a slant to the inside of the tank, so that it will not freeze and burst. Fill one foot with rock and then put on the cement grout, and so on till the tank is as high as desired. Plaster all over when dry. This kind of tank is 12 feet long, 30 inches high and 4 feet wide, can be built for $6 or $8 if you do the work yourself. In mixing sand and cement do not make too much mortar at a time, as it hardens quickly.—The National Cement Review.

A NEW PROCESS FOR MAKING BRIQUETTES.

THE various cementing materials used in making briquettes can be divided into two broad classes. The ones, like dextrin, cellulose, pitch, and tar, are of organic origin, while the others, such as lime, clay, gypsum, sodium silicate, etc., are of mineral or inorganic origin. The former are chiefly used in collieries, while the latter, mostly in the form of flux, are used in foundries, glass factories, etc. Pitch and tar have the decided advantage, when pure, of leaving no ash, while lime, clay, etc., of course do, although by using them judiciously the residue may be reduced to very small proportions.

A thing which had not been tried hitherto is the combination of these two expedients, the simultaneous use of organic and inorganic media in such a way as to utilize each to its best advantage. The universally high price of pitch and tar in Germany has lately induced Mr. Gehre to introduce such a process, with results which are entirely satisfactory. It has not been possible altogether to avoid a residue of ash, but this only amounts to about two per cent, and such a small quantity will hardly be felt in the case of briquettes made from coal rich in mineral matter, while in good anthracite briquettes it is altogether negligible. It is not to be forgotten that pitch and tar themselves leave a residue of ash, which, however, is not usually mentioned, as it is commonly supposed that they are completely burnt up. But this is not by

any means the case; the ash of the pitch, tar, etc., used for making briquettes exceeds in fact the residue from Mr. Gehre's product, for his cementing material leaves only 1.05 grammes out of every 3 grammes, while the pitch, etc., leave 1.36 out of the same quantity.

In his investigations Mr. Gehre found that the machinery in use for making briquettes requires little or no modification in order to be worked on his new plan. The mixture for the briquettes must be heated before or after consolidation. If the former course is chosen, care must be taken not to reduce the moisture of the mixture, as this prevents proper consolidation. But all mishaps can be readily avoided by the use of proper apparatus, the installation of which causes little extra expenditure. With such a plant also it is advisable to heat the finished briquettes for a time. The whole process is simple and easy to carry out.

The cementing material is mixed in varying proportions according to the coal used. Coal dust absorbs more moisture than does culm; anthracite needs less of the material than does cannel coal, coke requires more, etc.

One of the cheapest materials for briquettes is the residue from the process for recovering silver from zinc.

The briquettes obtained by this process offer several advantages. They are well adapted for transport, they resist the action of the atmosphere, they burn well and preserve their outline in doing so.

Their fuel value is equal to that of the raw material; they are rather less smoky than ordinary briquettes, The cost of manufacturing 10,000 pounds amounts to $2.75 at the present price of the material, but usually is still lower. The material used for cementing the dust is readily obtainable in all localities.

THE DANVIN DUST COLLECTOR.

WE give herewith, from La Nature, a perspective view and section of the Danvin dust collector, from which the simplicity of its construction and mode of operation may be readily seen.

The dust and other matter held in suspension in the gas or air is drawn in by a suction apparatus and forced into the separator, which they enter through the tangential orifice, *A*, and then traverse the spiral conduit shown in the figure to the right.

There is no need in dwelling upon the manner in which the iron plate jacket of the collector circumscribes the currents that form in the apparatus. In fact, the dust falls at *B*, where it may be collected after the plug at the bottom of the funnel has been unscrewed. The gas, or air, that has been purified escapes through *C*.

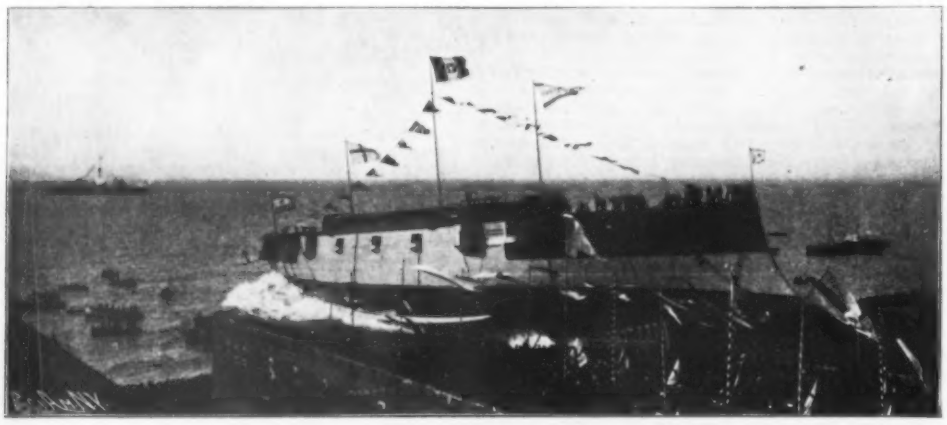
The experiments that have been made with the apparatus here shown show that it gives the same results as does a collector of the current type, of four or five timer larger dimensions.

LAUNCH OF THE ARGENTINE CRUISER "MORENO."*

By CHARLES DE GRAVE SELLS.

THE armored cruiser "Moreno," that has just been launched at the building yard of Messrs. Ansaldo at the Sestri Ponente near Genoa, for the Argentine navy, is sister ship to the "Rivadavia," launched from the same yard last October, and which so far holds the record for quick work, having been laid down only on March 10, 1902, and launched within seven months, while at the same time the second vessel had also to be pushed forward.

These two vessels belong to the far-famed "Garibaldi" class, of which type four ships have already been completed from the same yard, namely: "Garibaldi," Argentine navy, with cylindrical boilers; "Cristobal Colon," Spanish navy, with Niclausse boilers; "Pueyrredon," Argentine navy, with Belleville boilers; "Giuseppe Garibaldi," Italian navy, with Niclausse boilers; but many improvements have been made on the original type, especially in the armament and its fittings, in the means of supplying ammunition



LAUNCH OF THE ARGENTINE CRUISER "MORENO."

to the different pieces, in the electric arrangements and production, etc.

The principal dimensions of the vessels are as follows:

	Meters.
Length extreme	108.86
Length between perpendiculars	104.86
Width over armor	18.70
Mean draught	7.30
Displacement in metric tons	7700

The armor plates are hard-faced by the latest process and furnished by the Terni Steel Works. There is a central armored redoubt which extends for about half the length of the ship, the belt being 150 mm. thick at the sides, and the athwartship plates 120 mm. Outside the redoubt there is a belt extending a meter and a half above and below the waterline, of a thickness commencing with 150 mm. and diminishing to 80 mm. at the extreme ends.

The armored deck over the redoubt is formed of two plates with a total thickness of 40 mm. and beyond this is of 20 mm. thickness to the extreme ends.

The armament is as follows:

Four Q.F. 8-inch guns in the two barbettes fore and aft;

Ten Q.F. 6-inch guns in the main battery;

Four Q.F. 6-inch guns on the upper deck;

Four Q.F. 3-inch guns at the ends of the main battery.

Six Q.F. 3-inch guns on the upper deck;

Two Maxims in the fighting tops;

Two 3-inch guns for land use.

And there are also four torpedo tubes for above-water discharge in armored casemates. There are two main magazines situate directly under the fore and aft barbettes, and four for the secondary armament, two being in the center of the vessel, one forward and one aft.

The electric plant is considerably more powerful than has hitherto been fitted in vessels of this class, and is divided into two portions, three large dynamos being placed forward under the armored deck, and two others for general use on the upper deck amidships. The electric current furnished by these is used for general lighting and searchlight purposes, for the training gear of the guns, for the night sights, for firing the guns, for the ammunition hoists, for furnishing power to the workshop tools, the ventilating fans, the ash hoists, the air compressors, and for speed and direction indicators from the engine rooms.

The propelling machinery is of 14,000 I. H. P. and has been constructed at Messrs. Ansaldo's works at Sampierdarena. It should give the vessel a speed of over 20 knots an hour.

The coal capacity is about 1,100 tons, and the radius of action at 10 knots speed is about 9,000 miles.

The launch was an entire success, and took place in beautiful weather. The Duke of the Abruzzi was present, and the vessel was named by Madame Galindez, wife to Capt. Galindez, a member of the Argentine Commission. There were also present Commodore Garcia, the president of the commission; Marchese Garroni, the prefect of Genoa; Gen. Cerruti, commanding the district; Capt. E. Zezi, R. M. I., commander of the armorclad "Lepanto," which had been sent by the Italian Minister of Marine to salute the new cruiser as she entered the water; Commendatore C. M. Bombrini and the Senator Giovanni Bombrini, owners of the Ansaldo establishments.

After the launch of the "Moreno" she was towed to Genoa, and moored alongside her sister ship, the "Rivadavia" and the Turkish battleship "Messoudyeh," which has been recently reconstructed and rearmed by Messrs. Ansaldo, and is now waiting orders to leave for Constantinople.

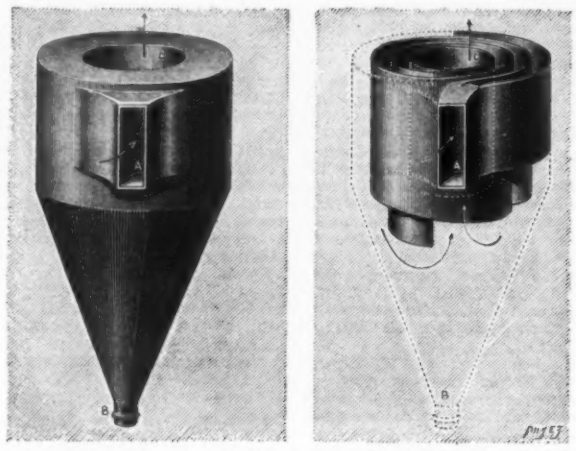
The completion of the vessel is to be pushed forward with all speed; and if these two ships are incorporated in the Argentine navy, they with their sister vessels will form a very formidable fighting unit, as there will be a squadron of six vessels composed of the "Garibaldi," "General S. Martino," "General Belgrano," "Pueyrredon," and the present two vessels in construction, the "Rivadavia" and "Moreno," all of the same class and approximately the same speed and armament.

Sampierdarena, Italy.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE DUKE DU BOURG DE BOZAS' EXPEDITION TO THE LAND OF THE BLUE NILE.

THE French expedition to the Blue Nile and Abyssinia, which was carried out under the Duke du Bourg de Bozas, recently arrived at Nimule, an English post on the Nile, having completed the journey. This expedition, which was carried out semi-privately and semi-officially by the Duke du Bourg de Bozas, left Jibutil, the French settlement, in April, 1900, for a prolonged journey through this little-known part of the African continent, and the expedition has been carried out with conspicuous success, many interesting discoveries having been made and a valuable addition being made to the present vague knowledge of this corner of the Dark Continent. The expedition first made its way from Jibutil to Harrar, where a stay was made until the requisite authority had been received from the Emperor Menelik to traverse and explore the southern provinces of Abyssinia and the region of the Arusi Gallas. The expedition was well equipped with medical, geological, botanical, astronomical, and zoological experts, so that every ramification of science indigenous to this region was studied thoroughly on the spot. Furthermore, to secure the partial, if not complete, adhesion of his following, the Duke organized a caravan composed of ninety-five members of numerous tribes, comprising Somalis, Abyssinians, Swahilis from Zanzibar, and Soudanese. Experience has taught travelers that a mixed caravan is the best protective measure against desertion, since mixed tribes seldom combine to act in concert against a white master. The animals consisted of eighty camels and forty horses and mules. The first part of the route traversed by the party was approximately due south and almost parallel to the Harrar River, as it was the object of the explorers to search the plateaus to the south of Abyssinia inhabited by the Arusi Gallas and Ogaden Somali tribes. This was a very monotonous journey, as the party passed through extensive regions absolutely uninhabited, and others only sparsely populated. Deserted villages in an advanced stage of ruin, choked wells, and other signs of civilization testified to the fact that the country had, at one time, been busy and well populated, but the inhabitants for some reason or other had migrated therefrom in a body. It was in this region that the expedition encountered its first hardships. The food supplies were exhausted, and had it not been for the plentiful supply of game, the party must inevitably have perished by starvation. To accentuate the difficulties, a large number of the camels died from eating a poisonous herb, the symptoms of which disease were closely similar to those produced by the tsetse fly, while, as the expedition passed through the Somali country, the Galla guides deserted.



THE DANVIN DUST COLLECTOR—EXTERIOR AND INTERIOR VIEWS.

The Duke du Bourg de Bozas attempted to replace the camels he had lost, but the Somalis refused to sell their beasts, and matters reached such a crisis that the expedition seized a well, and refused to surrender it until the natives agreed to part with the camels. By this drastic measure a new transport was organized, and the party set out toward Webi Shebeli. The leader of the expedition decided to explore the section of the river still unknown exhaustively. The caravan was split up, one portion following the course of the river in the collapsible boats with which the party were equipped, and the other section wended its way along the banks of the waterway, which was a very difficult undertaking. A thorough survey of the country was made, the courses of the rivers being set down, and the heights of the mountains correctly ascertained, while a large and representative collection of the fauna and flora of the region was obtained. A thorough investigation was also made of the various tropical diseases indigenous to this clime, together with the effects exercised thereby upon the natives, while a number of anthropological measurements and other physical data of the latter were also secured.

On December 28 the expedition returned to Adis Abbaba, where the caravan was overhauled, and reorganized, and on March 4 it set out once more from the Abyssinian capital to explore the lake region of the River Omo and the northern end of Lake Rudolf. The approach to the river was fraught with considerable danger, and attended with many difficulties, owing to the mountainous nature of the country. A

very comprehensive idea of the ruggedness of the region may be gathered from the fact that while climbing the mountains of Golfa, no less than twenty animals, together with their loads, were lost over the precipices. During this part of the journey to the Omo River, which is supposed to be the only feeder to the large inland Lake Rudolf, the measurements of 200 natives were secured, which were of great anthropological interest.

It was on the right bank of the Omo River that the expedition found the most valuable discovery of the whole journey. This was an extensive fossiliferous deposit, wherein were found the remains of numerous animals and flints belonging to a prehistoric era. Many large fishes were found in these fossiliferous deposits, together with two specimens of crocodiles, elephants, one of larger proportions than the present living types, while the other was that of a pigmy not more than one meter in height, three different specimens of the horse, hippopotami, pig, and antelopes.

From the River Omo the expedition set out toward the Blue Nile across the Turkana country, and met with considerable hostility from the tribes, but owing to the tact of the Duke, very little recourse had to be made to arms. The first signs of European influences and civilization were encountered 170 miles east of Nimule, the natives being garbed in cotton trousers and colored Zanzibari clothes.

Upon his arrival at Nimule, the Duke, instead of returning direct via the Nile to Europe, decided to push his way to the Atlantic coast, through the Congo Free State, though he dispatched his extensive collection of various descriptions, together with surveys and records, direct to Paris.

THE PLANIMETER, EXPLAINED SIMPLY, WITHOUT MATHEMATICS.*

By W. J. TENNANT.

CALCULATIONS of many kinds enter very largely into the daily work of the engineer. Unfortunately, the average mechanical engineer is not a good calculator

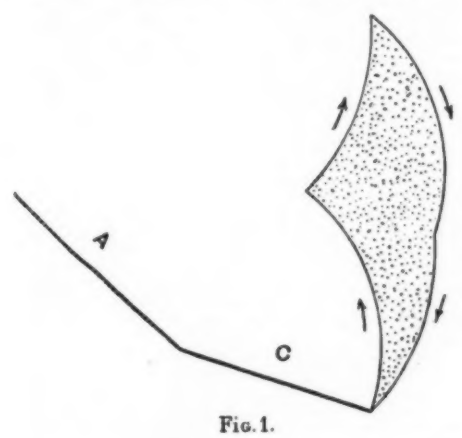


FIG. 1.

in the mathematical sense of that term. Though he sheds luster on his country in an engineering capacity, he shines rather in spite of than by reason of his mathematics. Prof. Perry at the Royal College of Science is changing all this. In the future our engineers are to be practical mathematicians. In the meantime as practical engineers they impress apparatus into their service to perform their calculations for them automatically. To the planimeter, one of two instruments commonly employed by engineers to perform calculation—the other being the slide rule—your attention is now to be directed.

It is frequently necessary for the engineer to ascertain the area of some flat surface or figure having a

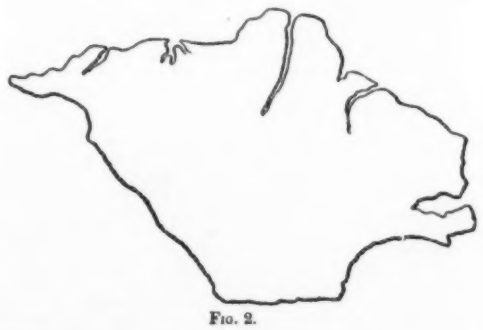


FIG. 2.

boundary which is not of regular form. Let us take, for example, an area such as that which is inclosed by the four curved lines in Fig. 1:

This area does not possess irregularity of outline in any very marked degree. It is chosen instead of a more striking example because it has an outline made up of four circular arcs, which may be of assistance to us presently when we analyze the motions of individual parts of the instrument. An instrument for measuring the area of the curve-bounded surface in Fig. 1, and of figures very much more irregular, like Fig. 2, the plan of an island, can be made up, as shown in Fig. 3, of three elements, each exceedingly simple. Two of them are bars, one of them, *A*, anchored by one end to a stationary pivot *P*, and pivoted at the other end to its companion *C*; anywhere on that companion bar, as on an axle, is a third element which is a graduated roller *R* free to turn, but not free to shift along

* Abstracted from a paper read before the Institution of Junior Engineers.

the bar, and geared by a worm to a disk by which the revolutions of the roller are counted; at the free end of the companion bar is a tracer-point *T*. In use the instrument is supported at three points by the parts

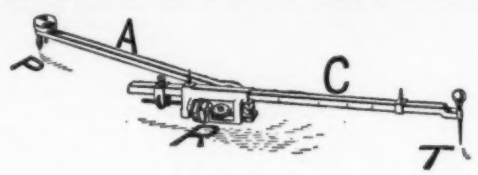


FIG. 3.

P, *R*, and *T*; if it rested on four on a surface which was "winding" the roller might not always bear properly, and could not always be relied upon to roll. Fix the stationary pivot somewhere outside the boundary of Fig. 1, and starting with the tracer from the bottom corner of that figure run it round the boundary back to the starting point, following the arrows. It is important to finish with the tracer precisely at the position from which it started, as by so finishing, the

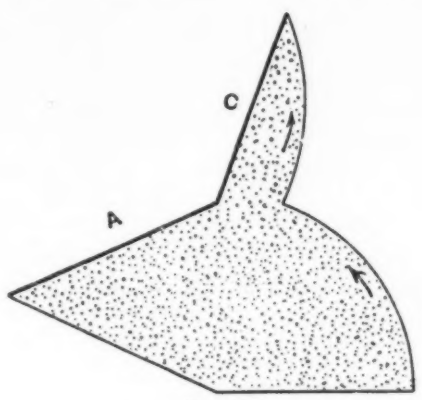


FIG. 4.

two bars also must come into the positions indicated in Fig. 1 by the heavy lines, whence they originally set out; and that they do so will make our further proceedings easy, as will presently be manifest. Moreover, if this precaution were not observed in practice the measurement of area would be incomplete and therefore inaccurate.

While the tracer-point ran round the figure the two bars traversed or swept over in their upstroke the

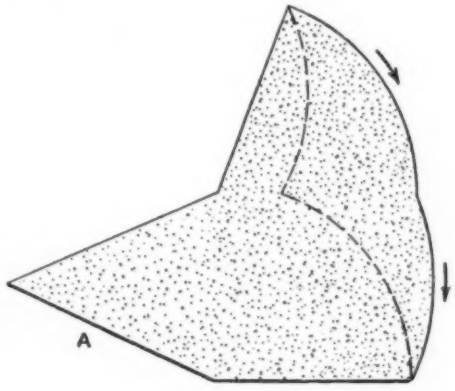


FIG. 5.

surface shown in Fig. 4, i. e., a surface altogether outside the boundaries of Fig. 1; in their downstroke they sweep back over another surface shown in Fig. 5, different only in that it is larger by inclusion of the area of Fig. 1. This is the principal fact for remembrance; expressed briefly, it is: That the surface area swept over in the upstroke and that swept over in the downstroke subtracted one from the other, leave us the area we seek. So that the area we seek is not, you see,

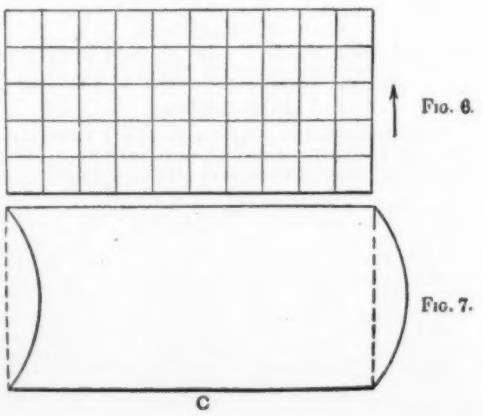


FIG. 6.

FIG. 7.

obtained by measurement of the circumference or perimeter of the figure—to the area of which, indeed, it would generally be no guide—nor is it going to be measured directly, but, instead, by the subtraction of two other areas. This to a mortal would appear to be a somewhat clumsy procedure; the instrument, however, finds it easier to work in this fashion.

One has next to show how it is that the bars and wheel are able to measure the upstroke and downstroke areas not pictorially—which would be of no particular advantage to us—but in, say, square inches, to subtract the one from the other, and to express to the user, also in square inches, their difference.

Note.—For a moment a digression is necessary in order to show that the value of an area swept in by a single bar moving sidewise without swing depends only on the sidewise movement and is not affected should the bar happen to move endwise, while its movement sidewise is occurring. Fig. 6 shows a bar 10 inches long—the heavy black line—sweeping in an area of 50 square inches by moving sidewise for 5 inches without moving endwise. Fig. 7 shows that precisely the same value of area is swept by the same bar if it has the same sidewise movement, but at the same time a movement endwise; a comparison of Fig. 6 with Fig. 7 will show that the endwise movement has had no effect on the value of the area; its shape alone has been affected, alterations compensatory to one another, e. g., a concavity balanced by a convexity occurring at opposite ends of Fig. 7 on which the preceding figure is shown by dotted lines. If this be clearly appreciated we will return to our mechanism in which such a bar *C* is used in company with another, *A*.

Everybody knows how conveniently a calculation is simplified if by good fortune the different factors cancel one another out so that only two remain to be dealt with. Such cancellations happily occur with the instrument we are using—except where the fixed pivot is inclosed within the circuit traversed by the tracer-point; this condition can generally be avoided in practice, but is considered further—and, as will be seen, no less than four factors out of six cancel and give no trouble. The first two factors cancel out thus—see Fig. 8, which shows the several movements made by the bars while the tracer-point traverses the perimeter

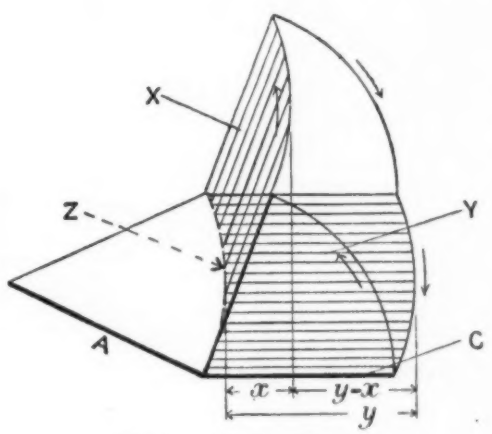


FIG. 8. (A PLANE FIGURE.)

of the figure shown in Fig. 1. The anchored bar, having "swept in," its share of the upstroke area descends and "sweeps in" precisely the same amount of downstroke area; these two areas not differing, one balances the other, and both can be disregarded, for after their removal the difference between the remainders of upstroke and downstroke areas continues to represent the area whose value we seek to ascertain.

The companion bar in playing its allotted part in the production of the remaining upstroke and downstroke areas swept out each area in two ways, i. e.: (1) By moving sidewise without swing—i. e., keeping parallel with its original direction, like a locomotive side

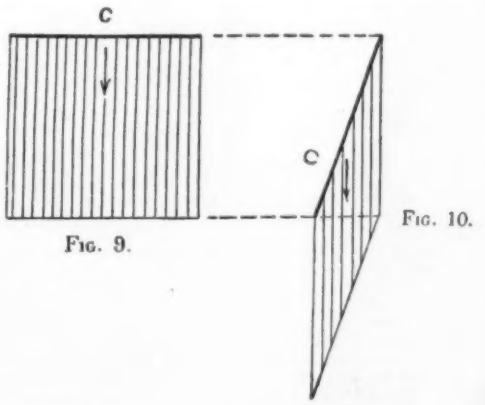


FIG. 9.

FIG. 10.

rod. Simultaneously it may perchance move endwise; but—see the preceding note—this endwise movement will be of no effect as far as the value of area swept in by the sidewise movement is concerned. (2) By swinging laterally of its own length into positions out of parallelism with its original direction. In moving sidewise without swing it must of necessity turn relatively to the anchored bar about the junction of the two bars in order to keep parallel with its original direction during the movement of the anchored bar. But this turning is not "swing" in the sense of (2).

No other kinds of movement are possible for it under the restraint imposed upon it by the anchored bar. As to the swinging of this companion bar, two more cancellations very comfortably result, for the installment of area swept in by this bar in swinging cannot avoid being swept again reversely by the same bar before it can get back to its starting place, when, as

you will remember, it will be found in occupation of its original position, so that it must finally have swung back over any areas of swing over which it swung forward after the start. This is equally true whether the swing after the start occurs in one sweep, or in a series of smaller sweeps succeeding one another and alternating with "pure" or non-swinging sidewise and endwise movement of the bar. In the measurement of any diagram, such, for instance, as Fig. 2, not specially arranged, to insure that the two motions of the companion bar shall occur in alternation they will more often than not occur simultaneously, the companion bar then receiving a single movement compounded of the other two; the case may be considered as an extreme example of that which is referred to in the preceding paragraph if the two motions are assumed as being alternated and of extreme minuteness instead of simultaneous. Further, it often happens that a swinging movement of the companion bar may mask a sidewise movement, if one occurs positively while the other occurs negatively; in such a case the area they sweep is the difference between the area swept in "swing" and that swept by sidewise movement without swing. Then it follows that as the upstroke and downstroke areas did not differ in those portions for which the swing of the anchored bar was responsible, and also do not differ in those portions accounted for by the mere swinging of the companion bar, they can only differ because of the difference between the portions that remain. The portions that remain are the upstroke portion or portions swept out by the movement of the companion bar endwise and sidewise without swing, and the downstroke portion or portions, obviously different in our example, swept out in similar fashion. These upstroke and downstroke areas are lettered *X* and *Y* respectively and shaded with parallel lines in the example illustrated by Fig. 8. The ratio of each area *X* and *Y* to that of the curve-bounded four-sided area in Fig. 8 should be obvious from inspection of the drawing. Note that the arc *Z* could sweep in the area *Y* by moving through a distance *y* perpendicular to its chord—keeping parallel with its original position while so doing—that it would sweep in *X* by similarly moving through *x*; and that it would sweep the curve-bounded four-sided area by moving through *y x*. Therefore, area *X* is proportional to *x*, area *Y* to *y*, and the curve-bounded four-sided area is proportional to the difference between the areas *Y* and *X*—or between the distances *y* and *x*.

Then our problem, gradually shorn of its original proportions by successive cancellations, comes down to this: How is it that the single companion bar sweeping out these two portions sidewise can subtract their areas one from the other and present to us an indication in square inches of their difference? It is thus: When a bar sweeps out an area by moving sidewise, keeping parallel with its original position the while, the value of that area in square inches is, whether the bar happens to move endwise or not: Length of the bar in inches, multiplied by the amount in inches of such sidewise movement measured in a direction at right angles to the length of the bar. The length of the bar is, of course, the same in both strokes. Suppose it to be 10 inches, and that its sidewise movement is 3 inches during the upstroke, and 10 inches during the downstroke, then the upstroke portion has an area 10 inches by 3 inches = 30 square inches, and the downstroke portion an area 10 inches by 10 inches = 100 square inches. The difference, 70 square inches, is the area sought.

Note.—It will be obvious that the extent to which the bar moves sideways, i. e., transversely to its length, during the upstroke, must differ from the extent of lateral movement made during the downstroke if one remembers that the mechanism is anchored to the fixed point, and that therefore the companion bar in moving along the side of the figure most distant from the anchorage, stretches across to it in a position more oblique, upon the whole, to the height of the figure than that which it occupies in traveling along the opposite side of the figure nearer the anchorage. A bar descending a given height while extended laterally as far as is possible across its line of travel—see Fig. 9—sweeps out more area than in an equal descent—see Fig. 10—made with the bar folded in nearer that line. One might be asked: "Suppose that the companion bar in moving sidewise without swing up and down a diagram oscillated? Suppose that in making its upstroke under constraint of the anchored bar it sometimes moved downward momentarily, as might very well happen if the diagram were of a less accommodating outline than that which is dealt with in Fig. 8?" The answer is that as the bar gets right up the diagram and right down again, all intermediate oscillations in a stroke must necessarily have canceled one another out by the way, for it could never be found at either end of its progress if intermediate backslidings had not been precisely recovered.

The Roller.—The length of the bar being 10 inches in both operations, every inch of sidewise movement will mean an area of 10 square inches swept over by the bar. Here the roller comes in. Put on the bar as on an axle, or mounted parallel to such a position, it will measure sidewise movement, and that alone; endwise movement, which we do not desire to take any account of, will not avail to turn it, whether the endwise and sidewise movements occur simultaneously or not. The roller is marked upon its edge to indicate, say, 10 square inches for every linear inch that the bar moving sidewise rolls it over the surface swept; if the bar "unsweeps" that area the roller will roll back again. In our example the bar "sweeps in" an area *X*—Fig. 8, and "unsweeps" a larger one, *Y*, so that the roller, rolled in one direction in the first operation, will be rolled back to its original starting point and past it in the second, hence the amount by which, finally, it is found to have turned during the movements of the bar, will represent the difference between the areas of the two remainders we have been considering, and will consequently indicate the actual area value we have all along been seeking. Swings will not affect the roller; the swings cancel, as you will remember, and any registration of swing by the roller will be canceled also by the compensatory reverse swing which always occurs between the start and finish of the operation of the instrument.

Results in Different Units.—Another point is that if the companion bar be shortened relatively to the anchored bar, say, halved in length for example, both the "companion bar areas" for a given figure, though preserving the same relative values as they possessed when swept into being by the unshortened bar, will be of altered shapes; the short bar will lie more obliquely to the height of the figure in producing them, and they will be narrower than before. More sidewise movement of the companion bar will have been needed to produce them. Each inch of sidewise movement of the bar will now sweep out only five—instead of ten—square inches, and the roller will consequently give a higher final reading, for it will be registering units of half the size of those originally chosen. In the instrument as usually made the companion bar has graduations marked upon it, and can be virtually shortened to different extents to enable the roller to give results in various units of the British and metric scales as may be most convenient.

Mean Height of Indicator Diagram from Planimeter by Direct Reading.—Reference to Fig. 8 will show that the planimeter may be considered to convert the area measured into a parallelogram—the parallelogram by which *Y* in that figure exceeds *X*—and to measure the area of that residual parallelogram indirectly, that is to say, by measuring its "height," or, in other words, its dimension perpendicularly to the companion bar. For this height of the parallelogram is the distance over which the roller runs and which it registers, and we are entitled to assume, as we do, the area from the height, only because we know that the other dimension of the parallelogram is the length of the companion bar, and is constant until we alter it. In dealing with an indicator diagram, to obtain the mean effective pressure, all that we require to know is the height of a parallelogram of an area equal to that of the diagram and of the same length. If we make the companion bar of the planimeter possess, by adjusting it, the same length as any given diagram, the residual parallelogram above referred to, which we know has in any case the same area as that of the measured diagram, and which we have made by this adjustment to have the same length, must therefore have the same mean height, and this mean height the roller will disclose directly if its circumference be graduated in suitable units. Generally the circumference is so graduated that it will give the desired height as inches if its reading be divided by 0.4. Had the length of the companion bar been greater, for instance, than the length of the measured diagram, the "residual parallelogram" would have had an increased length, and consequently a diminished mean height, i. e., a mean height less than that of the measured diagram.

Planimeters are sometimes made with one projecting finger on the back of the companion bar, and another on the back of the pivoted guide through which it is adjustable. By bringing these fingers to the opposite ends of a diagram, the tracer-point and joint at opposite ends of the companion bar are brought to be the same distance apart as are the opposite ends referred to, and the virtual length of the companion bar is thus made equal to the length of the diagram. The foregoing remarks are offered as dealing in elementary fashion with the Amsler planimeter in its normal operation. The principal features of its action, as the writer has attempted to show, are: (*a*) The sweeping of upstroke and downstroke areas, two—or more—in number, by a bar whose length does not change during the operation, but which lies upon the whole more obliquely to its line of travel during the one stroke than during the other, assuming the measured figure to possess area and not merely length without breadth, and (*b*) the automatic subtraction by the roller of these two classes of area one from another, so as to present an indication of their difference. This indication is the area of the figure, no matter how irregular, around the boundary of which the tracer has been run. An area of simple form has been chosen for the sake of example; where the area is of a more irregular outline a more varied assortment of swings and other movements of the bar would occur, but the several components of that assortment would all classify, as in our example, into

(1) Swings of the anchored bar.

(2) Swings of the companion bar;

all canceling, and

(3) Sidewise and endwise movements, without swing, of the companion bar.

Only the areas swept over by the movements under the third head have to be totaled for the up and downstrokes respectively and compared. This comparison and the subtraction of upstroke and downstroke areas one from the other, the roller effects.

The simplicity of the mechanism is obvious, and the beauty of the invention, which is great, is enhanced by the simplicity of the means employed to obtain practical results.

THE LATEST RESEARCHES ON THE DISCOVERY OF AMERICA BY THE NORTHMEN.*

By A. GEHLEN.

Two views about the discovery of the continent of America by the Northmen are prominent among American historians. The one, professed by Shea, maintains that the Northmen about the year 1000 of our era established flourishing settlements on the eastern shores of the American continent, and is based mainly on Rafn's monumental work: "Antiquitates Americanæ." The other more skeptical view, upheld by Bancroft, declares that "the colonization of America by Northmen rests on narratives, mythological in form and obscure in meaning, ancient, yet not contemporary," and that "no clear historic evidence establishes the natural probability that they (the Northmen) established the passage (from Greenland to Labrador)."† This latter opinion found its best representative in Winsor.‡ According to W. Curtis§ the discovery of the continent of America "rests entirely upon tradition, poetic legends and some slight circumstantial evidence."

That a modification of either theory would be nearer the truth is proven conclusively by the latest book of Rev. J. Fischer, S. J., "The Discoveries of the Northmen in America."*

We shall attempt in the following to give the outlines of Fr. Fischer's researches and arguments.

The oldest written document about the discoveries of the Northmen in America is that of the learned and reliable historian of the North, Canon Adam of Bremen, a contemporary of Archbishop Adalbert (1043-1072), the famous educator of the reckless Emperor Henry IV. To obtain definite information about the countries of the North, he paid a visit to the Danish king Sven Estrithson, who "preserved the whole story of the barbarians (Northmen) in his memory, as if it had been written therein."† From the trustworthy narration of the king and other Danes, Adam learned the discoveries of the Northmen in America: Greenland and Vinland. In the latter, according to him, vines and corn grew wild. Fischer sums up his judgment about Adam in the following words: "Adam's testimony is the oldest written document about the discoveries of the Northmen in America; it is quite independent of the written Icelandic literature and rests immediately on the northern traditions, then still fresh and vigorous."

Another not less trustworthy authority is the Icelander Ari Thorgilson, called *hinn fróði*, i. e., the "much-experienced" (died 1148). He gained his knowledge from his uncle Thorkel Gellisson of Helgafell, who in turn derived his information from a companion of Eric the Red, the discoverer and first settler of Greenland. Ari tells us, in his "Icelandbook," about Greenland, its discovery, its first settlements and the civilization of the aborigines. Without giving any description of it, he speaks of Vinland as of a country generally known.

Three more documents, which probably go back to Ari, treat of Greenland and Vinland: the Landnamabook, the Kristisaga, and Snorri's Kœnigssaga.

These two historians of the North are happily supplemented by a geographer of the middle of the twelfth century, probably the Icelandic Abbot Nicolaus von Thingeyre (died 1159). His account is found in Icelandic documents of the fourteenth and fifteenth centuries. According to these sources "Helluland is situated in the south of Greenland, next comes Markland and thence it is not far to Vinland the Good, which is said to be connected with Africa. . . . . Lief the Happy was the first to find Vinland."

Also the other Icelandic *sagas*, i. e., town and family chronicles, occasionally mention Vinland. Thus the Eyrbyggsaga (about 1250 or 1260) relates that Snorri, the son of Thorbrand, went with Karlsefni to Vinland the Good, where they fought with the Scraelings, the aborigines of the country. In the Grettisaga (about 1290) Thorhallr Gamlasa tells us that he too had taken part in the expedition of Karlsefni to Vinland; that after this expedition he had settled upon Iceland at the Hrutafjord and had been called from his voyage the Vinlander.

The records mentioned above, and to the greatest part overlooked by earlier writers, even by Winsor, contain, it is true, only short notices about Vinland. But they bear witness to a uniform tradition throughout the whole North, as far back as the eleventh century.

Many more details than in these historically reliable narrations of Adam, Ari, and the oldest sources are contained in the Icelandic sagas of the thirteenth and fourteenth centuries. But as they are more remote, also their trustworthiness is diminished, and thus we find that their relations disagree in the most essential points. According to the critical researches of the Scandinavian historians Reeves‡ and Storm§ only three deserve special attention: the Saga Thorfinn Karlsefni's in the Haukbook (about 1305-1335), the Saga of King Olaf in the Flateybook (about 1387) and the Saga of Eric the Red in a copy from the beginning of the fifteenth century.

The Saga of Karlsefni agrees in all essential points with that of Eric the Red. And their relations both agree fully with the oldest sources, while the poetical Flateybook contradicts them in the most important points and contains, besides, a number of improbabilities. From the historical point of view, therefore, the Haukbook and the Saga of Eric the Red deserve the preference. But unhappily the Flateybook was mainly consulted in all the first accounts of the Norse discovery of America, and since Rafn followed the same relation in his "Antiquitates Americanæ," it passed over into most of the scientific and popular treatises on the subject. Fischer, naturally, with Storm and Reeves, gives decided preference to the Haukbook, which contains a detailed description of the Vinland-voyages in full harmony with the oldest reports.

According to the Haukbook, Leif, a son of Eric the Red, sailed in the year 999 from Greenland to Norway. This voyage, compared by Storm to that of Columbus, was probably undertaken for the purpose of establishing a direct route to the newly founded colony on Greenland, in order so to prevent isolation. For the uncertainty of the passage by way of Iceland had been demonstrated by the fact that of the thirty-five ships with which Eric had sailed from Iceland to Greenland in 984, twenty-one had been wrecked by the polar-stream or at least prevented from reaching their destination. Later on Thorgil, at the invitation of Eric, followed him to Greenland. But he was ice-bound for three years and only reached Eric after untold sufferings and hardships of every description.

The report of the Haukbook about Leif's voyage continues as follows: "In Norway Leif entered the service of King Olaf Tryggvason and was converted to Christianity. In the year 1000 Olaf sent him home together with a missionary priest to promulgate Christianity on the island. On this voyage Leif's ship was

---

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

† G. Bancroft, History of the United States, Vol. I., c. I.

‡ Winsor, History of America, I., p. 66f., p. 87; II., p. 33.

§ Curtis, The Relics of Columbus, p. 7.

* Joseph Fischer, S. J., Die Entdeckungen der Normannen in America. Freiburg. Herder. 1902. For a more detailed narration, especially for a minute account of the sources, and for excellent illustrations we refer to the work itself.

† Adam. Brem., Gesta, lib. II, C. 41.

‡ Vinlandsreiserne, p. 13-21.

§ Wineland, pp. 19-25, 53-57.

carried away by storms and after many wanderings Leif discovered a country previously unknown. He there found wild grapes and wheat, took along specimens of each, and sailing northeast he finally arrived in Greenland. In the winter of 1000-1001 Christianity was introduced into Greenland, although Eric the Red seems to have been opposed to it in the beginning. The adventures and discoveries of Leif had excited among his countrymen a keen interest for the newly discovered countries. Thorstein, the elder brother of Leif (highly praised in the sagas), undertook an expedition, but severe storms rendered it unsuccessful. In the summer of 1002 two Icelandic ships landed near Brattahild, the homestead of Eric. The one belonged to Thorfinn Karlsefni, an enterprising merchant, the other to the Icelanders Bjarne and Thorhall. They were received as guests by Eric, and in the following spring Karlsefni married Gudrid, the young widow of Thorstein, who had died shortly after his return to Greenland. Karlsefni likewise yielded to the fascination of a voyage of discovery. One hundred and forty persons joined the expedition, which was crowned with success. First they came to a country remarkable for its long, flat stones, which they called Helluland, i. e., 'stoneland.' A further voyage of two days brought them to a place distinguished for its large woods; accordingly it was called Markland, i. e., 'woodland.' After another long and troublesome voyage they reached a third land, and Karlsefni sailing southward along the shore finally came to a place where he found wild grapes and wheat. He felt convinced that this was Vinland the Good. As the country seemed fit for colonization, they forthwith erected several dwellings. Numerous natives approached them in leathern boats to exchange goods with them. But this peaceful intercourse was soon disturbed; a bloody contest arose, in which the Icelander Thorbrand fell. It was only after many losses that the Skraelings—thus the aborigines were called—withdrew. Apprehensive of a new attack, Karlsefni left the spot and tried to found settlements on a tract farther north. There they were unmolested by barbarians. But soon differences occasioned by the women of the colony arose among the settlers themselves. In the summer of 1006 it was therefore agreed to give up the settlement. On his return Karlsefni once more landed at Markland. He found five Skraelings on the shore, three of whom, a man and two women, escaped, while two children were caught and carried away. Karlsefni and Gudrid with their young son Snorri (who was, as far as we know, the first child born of European parents on the continent of America) arrived happily in Greenland. The worm-eaten vessel of Bjarne, however, perished in the waves; and only half the crew saved themselves to Iceland. Among the drowned was the noble Bjarne, who sacrificed himself for a younger companion."

Storm* has instituted most thorough and minute researches to determine the situation of the three countries discovered by the Northmen. Inquiring into the different statements of the *sagas* about the starting point, the length and the direction of the voyage of Karlsefni, he came to the following conclusion, in which he is seconded by other authorities: Helluland corresponds to the modern Labrador, including the northern peninsula of Newfoundland, Markland to Newfoundland, and Vinland to Nova Scotia and Cape Breton Island. Storm proves in detail, that the description given by the Haukbook of the coasts visited by Karlsefni with the stations Hop, Straumsfjord, Kjalarnaes and Krossnaes tallies perfectly with these countries. The wild wheat mentioned by the Northmen is clearly the Indian rice (*Zizania aquatica*), which still to-day grows on large tracts in those regions; and the wild grape-vine is now found as far north as Canada. Whether the Skraelings were Eskimos or Indian hunting tribes, cannot be definitely ascertained, but the latter view is the more probable.

These facts about the discovery of the American continent by the Northmen are gleaned from history and are by no means based on a mere "mythological narrative." However, as to these flourishing settlements on the shores of the Atlantic during the eleventh century, of which certain historians speak, history is silent. The Vinland colony of Karlsefni, as we have seen, was abandoned after a short time. About any other attempt to establish a settlement on the American continent neither the Haukbook nor the other Icelandic sources offer any information. In regard to Vinland we possess only one historically certain record, namely, that of the missionary expedition of Bishop Eric in the year 1121. The simple record of the Icelandic annals for that year runs thus: "Bishop Eric started from Greenland to seek Vinland." As to whether he reached his destination, whether he preached the Gospel there and founded a Christian colony, we are left in entire ignorance. Imaginative writers, as Lyshander in his "Greenlandic Chronicle" (1609) and many after him, have amplified this short statement and speak of the great progress of Christianity and civilization in Vinland; but this is poetry rather than history.

Since the time of Rafn the ruins of the Northmen at Newport, R. I., were always brought forth as the main argument. But it is now acknowledged by all professed scholars that the so-called "Norman Tower" at Newport is nothing else than the remnant of a windmill, erected by Governor Arnold (about 1670-1680), the model of which stands at Chesterton, England, the home of the governor."†

Another proof, often advanced in popular writings, is the inscription of the Dighton-Rock. But even Horsford, otherwise a staunch defender of a lasting Norse colonization in America, recognizes in this inscription a piece of Indian picture-writing. They are no Runic, but "originally Algonquin characters." "Such logic," remarks Mallery,‡ "would bring the Vikings very far inland, even to West Virginia and Ohio."

It would lead us too far, were we to refute all the other arguments adduced as evidences of a lasting colonization of Vinland. This has been done by Gelcich, Winsor and others, to whose works we refer the reader. Hitherto it was impossible, despite careful researches, to prove the existence of any Norman ruins or other antiquities. On the other hand we think ourselves justified in declaring with Fischer, in opposition to Bancroft and Winsor, that we have real historical evidence bearing on the discoveries of the continent of America by the Northmen. Helluland, Markland and Vinland, i. e., the eastern shore of our continent, were in truth transiently visited by the Northmen, although the intended colonization produced no lasting results.

* Vinlandsreiserne, p. 40 et seq.

† Cf. Winsor, History of America, III., 184-218; Gelcich, Zur Geschichte der Entdeckung Americas, p. 162 et seq.

‡ Picture-writing, p. 704.

TWO RECENT VISITS TO THE FORBIDDEN CITY OF LHASA.

DESPITE the many frequent attempts which have been made to penetrate Lhasa, the residence of the Lama, few have succeeded in passing its gates. Several explorers have managed to reach the outer walls, but were prevented from going further. Two Buddhists, scientifically trained men, last year succeeded in spending some time in the forbidden city, and have gathered information which will no doubt be of great interest and value.

One of these Buddhists, a Buriat, Zybikov by name, and sometime student of the University of St. Petersburg, set out a year ago for the city on a mission for the Imperial Russian Geographical Society. His religion aided him immensely. Not only was he unopposed, but he was even allowed to roam about the city and to take away with him many valuable curios. Among the *trouvailles* which this Buddhist succeeded in capturing was a collection of works by renowned Lamas. According to the New York Sun, these works comprise 319 volumes, containing 122,000 pages, and are devoted to an exposition of philosophy, astronomy, history and geography as these branches of science are understood by the Lamas of Thibet.

This unique Oriental library has been presented to the Asiatic Museum at St. Petersburg, where scholars will have an opportunity to study the volumes. It is not yet reported whether he was able to carry out any topographic surveys, but it is expected that he will publish the story of his journey.

The second visitor to Lhasa last year was a Buddhist student from Japan, whose name has been kept from the newspapers of India that have been permitted to print some facts with regard to his visit. He was well received and succeeded in the main purpose of his visit, which was to study the differences between the Buddhist ritual in Lhasa and in Japan. He intends to publish an account of his journey in the Japanese and English languages.

The routes taken by these travelers have not been made known. The fact, however, that the Buddhists of Thibet are beginning to extend hospitality to those of other countries who are in close touch with Western civilization is an indication that it will not be so difficult hereafter to obtain tidings of what is going on in the inner part of Thibet.

It is not too much to expect that the connection formed between these educated visitors and the people of Lhasa may gradually result in modifying the antagonism that is felt in Thibet toward all things foreign.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Arsenic Deposits in Ontario.—Consul H. S. Culver sends from London, Canada, April 6, 1903, the following newspaper clipping:

"The arsenic which for many years baffled the gold miners of Hastings County, Ontario, in their efforts to extract the precious metal from its matrix has become the more profitable of the two minerals. This strange turn of the wheel of fortune has been caused by the virtual exhaustion of the former chief source of supply of arsenic in Germany and England, together with the superior quality and purity of the Canadian product. A very few years have elapsed since the Canadian Gold Fields, Limited, a wealthy English company—who had successfully introduced the bromo-cyanogen process in treating the previously refractory mispickel at their mines in the township of Marmora—commenced the production of arsenic, of which they are at present turning out some 80 tons per month. That the business is a paying one is apparent, if the statement furnished by an old miner of great experience be correct, namely, that arsenic which can be placed on the cars at Marmora at a cost of $20 per ton commands $65 per ton and has been sold for as high as $87 per ton. But it is also true that this arsenical ore carries from $4 to $60 per ton in gold, which experience has shown gives a handsome profit in itself. As gold is not found in conjunction with arsenic in England and Germany, it will be seen that the Canadian miners have an enormous advantage—an advantage so great that the Hastings region can not fail to become in the near future the chief source of the world's supply of arsenic.

"As to the quantity of mispickel that this region produces, it is said to be virtually illimitable, as veins have been found in several of the neighboring townships, and doubtless many more will be found, as prospecting will be strongly stimulated by the recent visit of European capitalists in search of arsenic properties."

Flax Market in Germany and Bohemia.—Consul Hugo Muench sends the following from Zittau, March 24, 1903:

Referring to my report of August 21, 1902,* I may add that the unusually cold and wet summer and fall of 1902 affected flax culture in the Russian provinces from which the raw material for the linen industry of Germany and Bohemia is imported. The excessive moisture did not affect the natural quality of the fiber, but retarded its development. In quantity, too, the crop is reported to be average. Frosts interrupted the retting process. According to report, many of the producers withdrew the fiber from maceration, dried and stocked the same, and prepared to resume work during the warmer season of 1903. The proportion of the crop thus withheld from the market can not be established, but it must be large, as the flax market, which, owing to increased production, was expected to drop, has, on the contrary, perceptibly stiffened. The demand for flax yarns has also experienced a decided increase, prices have risen, and the various spinning establishments in these parts are well supplied with orders. If there is any surplus stock of prepared flax in the hands of our American producers, now is the time to place it on this market. Either this office or the establishment of H. C. Mueller ("Flachs-Spinnerei Hirschfelde," in Sachsen) will be glad to answer all pertinent inquiries.

* Advance Sheets No. 1451 (September 23, 1902).

Trade Notes from Albania and Montenegro.—The official organ of the Royal Hungarian Commercial Museum in this city calls attention to the Albanian and Montenegrin markets for foreign goods.

Hungary, Austria, and Italy are rivals in Albania, but the last named has various advantages—first, by obtaining from Turkey the right to set up Italian post offices in the chief Albanian cities; second, by establishing import and export offices in Italy for Albanian imports and exports; and, third, by opening a bank in Venice for Albanian financial intercourse. The Commercial and Transportation Company, of Sarajevo, Bosnia, has appointed an agent in Albania.

The principality of Montenegro, which is in close touch, commercially, with North Albania, has never had a representative from the United States. Its import of grain, articles of personal use, and ammunition of all sorts amounts to more than $100,000 in value. It uses Austro-Hungarian money and is therefore commercially united with Hungary, Austria, and Bosnia.

Both Albania and Montenegro offer a good market for American firearms.

Emigration to the United States has already begun from Bosnia, Montenegro, and western European Turkey.—Frank Dyer Chester, Consul at Budapest.

Industrial and Agricultural Exhibition at Limoges.—An exhibition will be held at Limoges from May to November, 1903, to display the industrial, agricultural, and artistic work of this part of the country and France in general, and also to show to the exporters and importers of the world the products and needs of this locality.

This is the first exhibition of its kind that has been held in central France for many years. Few foreigners visit Limoges. It is a city of about 90,000 inhabitants, and is known to the United States chiefly through its ceramic industry, which is the most important in all France.

To certain American exporters, this exhibition offers a valuable opportunity—the city being the center of a large agricultural region—to display farm machinery and implements, dairy machinery, etc. Carriage, shoe, leather, and harness manufacturers and dealers might also find it to their advantage to make an exhibit. A large and growing market has recently been created for American evaporated and preserved fruits, and no better opening for such merchandise could be found.

It would also be of interest to cattle raisers to visit this place, as they will find exhibits of the pure Limousin breed of cattle, which are especially adapted for beef.

If Americans desire to exhibit, space can be retained for them at a nominal figure, and the cost for the entire season would not be high. Although the exhibition opens officially on the 15th of May, 1903, special privileges will be granted to American exhibitors so that they can enter as late as the month of July. The exhibition will close November 1, and it will be during the latter months that this city will be thronged by the largest number of visitors.

Inquiries may be addressed to either the consulate of the United States or M. Raoul Saulay, directeur-general de l'exposition, Rue d'Isly, Limoges, Haute Vienne, France. I inclose prospectuses.*—Walter T. Griffin, Commercial Agent at Limoges.

British Inquiry for Can Openers.—Consul Marshal Halstead, of Birmingham, under date of March 28, 1903, says that he has an inquiry for the address of the Brown & Dowd Manufacturing Company, makers of the "Never-slip" can opener.

Machines for Trimming Wall Paper.—Consul Marshal Halstead writes from Birmingham, March 30, 1903:

I am informed that in England scissors are still used to cut the selvage of wall papers, while in America there is in general use a selvage-trimming machine, and I would be glad to have a catalogue of such machines.

Demand for Machinery in South Africa.—Under date of March 14, 1903, Consular Agent W. D. Gordon, of Johannesburg, informs the Department that he is in receipt of inquiries for data relative to cotton gins and equipment, brickmaking and cane-sugar machinery, and oil presses for extracting oil from peanuts and other nuts of a similar nature. The consular agent adds that if catalogues, with prices and shipping weights, are sent him, he will place them in the hands of interested parties.

* Filed in the Bureau of Foreign Commerce, where they may be examined by persons interested.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1625. April 20.—Zinc Industry in Europe—Zinc Industry in Algeria.

No. 1626. April 21.—German Apparatus to Draw Water from Cylinders—Trade Marks in Chile—Colombian Import Duties.

No. 1627. April 22.—Russia's Commercial Relations with Manchuria—Foreign Houses in Chemnitz—New Dock at Bombay—German Exports to the United States—Shark Fins in Nicaragua.

No. 1628. April 23.—Primary Commercial Education in Germany—*Demand for Machinery in South Africa.

No. 1629. April 24.—Taxes and Regulations for Foreign Commercial Agents—*Industrial and Agricultural Exhibition at Limoges—*British Inquiry for Can Openers—*Machines for Trimming Wall Paper.

No. 1630. April 25.—*Trade Notes from Albania and Montenegro—New Danish Steamship—*Arsenic Deposits in Ontario—Communication Between Italy and the Balcan States—*Flax Market in Germany and Bohemia—Harbor Works in Turkey.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

How to Print and Register Colors on Linen, Etc.—Fairly good register may be obtained by cutting either of the fabrics in layers on a cutting machine, whereby straight edges may be assured, and feeding the sheets up to gages. Of course, this is attended with great risk of spoiling the material if the greatest care is not exercised. A better plan is to insert two sets of metal points—one set to a form in each of the first two colors printed, and point through these on the feedboard of the press, namely, register the second color by the points in the first form and then use the point marks printed on the second color for the third color. In any event, the press must be run quite slow to secure the best results.—Inland Printer.

Printing on Celluloid.—Printing on celluloid, as well as on aluminium, may be done in the usual way, that is, make ready the form so as to be perfectly level on the impression—that is, uniform to impressional touch on the face. The tympan should be hard. Bring up the form squarely, allowing for about a three or four sheet cardboard to be withdrawn from the tympan when about to proceed with printing on the celluloid; this is to allow for the thickness of the sheet of celluloid. Use live, but dry and well-seasoned rollers. Special inks of different colors are made for this kind of presswork; in black a good card-job quality will be found about right, if a few drops of copal varnish are mixed with the ink previous to beginning to print.—Inland Printer.

Manufacture of Pudding Powders.—According to F. Grischow, who gives this information from his practical experience, the basis of the pudding powder consists of a mixture of powdered wheat starch and powdered sugar in equal parts. In order to impart to the finished pudding the necessary looseness, a little bicarbonate of soda and cream of tartar is admixed, while the yellow-egg or reddish color (in the case of raspberry and strawberry puddings) is obtained by means of nonpoisonous aniline dyes, which after having previously been ground with a little alcohol and then mixed with a small quantity of powdered sugar, are added to the basis. Since no special nutritive value is looked for in the pudding, the addition of dried yolk of egg or so-called "egg preserve," recommended by another authority, which would considerably increase the cost of production, may well be omitted. Of this mixture 100 grammes suffice for the preparation of a good pudding by means of half a liter of boiling milk. The aroma is produced by the artificial perfumes of the respective fruits, not by the fruits proper. Such fruit essences can be bought from any wholesale drug house. It is advisable, however, since they are put on the market in various strengths, to make a trial mixture of a small quantity of the pudding powder, before placing the preparation on the market.

The amounts given below of the different kinds of aroma are weighed out, the pulverulent ones are rubbed up fine separately and mixed with the prescribed amount of sugar. Gelatin capsules or tight pasteboard packages lined with oil paper are now filled with 100 grammes of this mixture each, and the contents of each capsule are used for ½ liter of milk. The finished powder, including capsule, folding box, etc., stands in about 8 pfennigs (2 cents) per package, while the public is ready to pay 20 to 25 pfennigs (5 to 6 cents) for it.

Basis.—Powdered wheat starch 500 grammes, powdered sugar 500 grammes, bicarbonate of soda 20 grammes, powdered cream of tartar 45 grammes, orange yellow or raspberry red 0.2 gramme (the color should first be ground with a little alcohol rubbed up with a small quantity of powdered sugar and only then be added to the rest). Mix all well, and after admixture of the aroma compounds given below fill in folding boxes containing 100 grammes each and bearing the following label: Pudding powder with ——— flavor for the quick and easy preparation of excellent puddings or creams without eggs, sugar, starch, or other ingredients, except pure milk.

Directions of Use.—Put ½ liter of milk on the fire, and mix the contents of this package with about 7 tablespoonfuls of cold milk in a dish (preferably by means of an egg beater). As soon as the milk boils, remove it from the fire and immediately add the mixed powder, stirring constantly. The whole is then left on the fire for a short time longer, with incessant stirring, and is then poured into a moistened mold, which is placed in the ice box or in cold water to cool off. For the preparation of cream double the quantity of milk is employed.

Aroma mixtures for 10 Kilos of Powder Each.—Vanilla: Vanillin 4 grammes, powdered sugar 56 grammes. Lemon: Lemon oil 10 grammes, carbonate of magnesia 5 grammes, powdered sugar 50 grammes. Almond: Bitter almond oil free from prussic acid 5 grammes, carbonate of magnesia 5 grammes, powdered sugar 50 grammes. Pineapple: Pineapple essence 5 grammes, carbonate of magnesia 5 grammes, powdered sugar 50 grammes. Peach: Peach essence 5 grammes, carbonate of magnesia 5 grammes, powdered sugar 50 grammes. Strawberry: Strawberry essence 5 grammes, carbonate of magnesia 5 grammes, powdered sugar 50 grammes. Raspberry: Raspberry essence 5 grammes, carbonate of magnesia 5 grammes, powdered sugar 50 grammes.

Chocolate Pudding Powder.—To every 100 grammes of the foundation add 20 grammes of unoiled cocoa powder, so that the package weighs 120 grammes. The cost of production is somewhat higher, so that the sale price must also be higher (about 30 pfennigs = 7½ cents).

As a sauce for all these puddings, excepting that with chocolate flavor, any kind of fruit juice is used (raspberry, cherry, or currant juice). With the cocoa pudding a vanilla sauce has to be served, which is prepared according to the following receipt: Vanilla sauce powder: Powdered sugar 30 grammes, powdered wheat starch 6 grammes, vanillin 0.02 gramme, orange yellow 0.015 gramme (the last named has to be previously rubbed up with a little alcohol, mixed with sugar, and only then should be added to the remaining substances). Directions: Stir with about 200 grammes milk, boil up with stirring, and put on ice.—Pharmaceutische Zeitung.

VALUABLE BOOKS

NOW READY.

Twenty-Third Edition

EXPERIMENTAL SCIENCE.

By GEORGE M. HOPKINS.

Revised and Greatly Enlarged. 2 Octavo Volumes. 1,100 Pages. 900 Illustrations.

Cloth Bound, Postpaid, **$5.00.** *Half Morocco, Postpaid,* **$7.00**

Or Volumes Sold Separately:

Cloth, **$3.00** *per Volume. Half Morocco,* **$4.00** *per Volume.*

EXPERIMENTAL SCIENCE is so well known to many of our readers that it is hardly necessary now to give a description of this work. Mr. Hopkins decided some months ago that it would be necessary to prepare a new edition of this work in order that the many wonderful discoveries of modern times might be fully described in its pages. Since the last edition was published, wonderful developments in wireless telegraphy, for example, have been made. It was necessary, therefore, that a good deal of new matter should be added to the work in order to make it thoroughly up-to-date, and with this object in view some 300 pages have been added. On account of the increased size of the work it has been necessary to divide it into two volumes, handsomely bound in buckram. It may be interesting to note the following additions that have been made to these volumes:

Volume I contains in addition to a large number of simple, well illustrated experiments, a full description of a ¼ H. P. electric motor made expressly for illustration in this edition of "EXPERIMENTAL SCIENCE." It is an ENCLOSED SELF-REGULATING electric motor for a 110 volt circuit. It can be operated by a current from a 110 volt lamp-socket, yielding a full ¼ H. P., or it may be used as a dynamo, furnishing a current capable of operating three 16-candle power, 100 volt incandescent lamps. The construction of the machine is perfect enough to admit of enlarging or reducing its size if desired.

Volume II contains much on the general subject of electricity, besides new articles of great importance. Among these the subject of alternate current machinery is treated. Wireless Telegraphy and Telephony receive attention. Electrical Measuring Instruments, The Electric Clock, The Telegraphone, Experiments in High Voltage, The Nernst Lamp, and Measuring the Heat of the Stars are all thoroughly illustrated and described.

The unprecedented sale of this work shows conclusively that it is the book of the age for teachers, students, experimenters and all others who desire a general knowledge of Physics or Natural Philosophy.

SIXTEENTH REVISED AND ENLARGED EDITION OF 1901

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts, Notes and Queries

15,000 RECEIPTS. 734 PAGES

Price, **$5** *in Cloth;* **$6** *in Sheep;* **$6.50** *in Half Morocco, postpaid.*

This work has been revised and enlarged. **900 New Formulas.** The work is so arranged as to be of use not only to the specialist, but to the general reader. It should have a place in every home and workshop. A circular containing full Table of Contents will be sent on application.

Those who already have the Cyclopedia may obtain the **1901 APPENDIX.** Price, bound in cloth, **$1** postpaid.

The Progress of Invention in the Nineteenth Century.

By EDWARD W. BYRN, A.M.

Large Octavo. 480 Pages. 300 Illustrations. Price **$3** *by Mail, Postpaid.*

Half Red Morocco, Gilt Top, **$4.**

The most important book ever published on invention and discovery. It is as readable as a novel, being written in popular style.

The book gives a most comprehensive and coherent account of the progress which distinguishes this as the "golden age of invention," resulting in industrial and commercial development which is without precedent. A chronological calendar of the leading inventions is one of the most important features of the book, enabling the reader to refer at a glance to important inventions and discoveries of any particular year. The book is printed with large type, on fine paper, and is elaborately illustrated with 300 engravings and is attractively bound.

1902 EDITION.

ALL THE WORLD'S FIGHTING SHIPS

By FRED T. JANE, Author of the Naval War Game (Kriegspiel).

Used as a text-book in European navies. The only absolutely correct and complete work of the kind published.

394 PAGES. OVER 3,000 ILLUSTRATIONS.

OBLONG QUARTO. CLOTH. PRICE, $5.00, POST FREE

CONTAINS:—A photograph of every warship in the world; also a silhouette and a gun and armor diagram of each vessel.

CONTAINS:—The length, beam, draught, horse power, speed, coal supply, number and size of guns, thickness and disposition of armor of every warship in the world.

CONTAINS:—Tables of the size, weight, velocity, energy, penetration, etc., of every gun of every navy in the world.

CONTAINS:—A series of chapters by noted Admirals, Naval Constructors and other experts of various navies, on vital questions of the day in naval construction, tactics, and strategy.

CONTAINS:—A comparative table (by the author) of the strength to the navies of the world—the most scientific attempt yet made to classify the world's warships and navies as to actual fighting strength.

IT SHOULD BE NOTED that this work is from the pen of a naval critic and expert, whose reputation is far-reaching on both sides of the Atlantic. It will be of fascinating interest to those who follow the course of naval development, and as a book of reference should find a place in every library.

JUST PUBLISHED.

HARDENING, TEMPERING, ANNEALING AND FORGING OF STEEL.

By JOSEPH V. WOODWORTH,

Author of "Dies, Their Construction and Use."

Octavo. 280 pages. 200 Illustrations. Bound in Cloth. Price $2.50.

A new work from cover to cover, treating in a clear, concise manner all modern processes for the **Heating, Annealing, Forging, Welding, Hardening and Tempering** of steel, making it a book of great practical value to metal-working mechanics in general, with special directions for the successful hardening and tempering of all steel tools used in the arts, including milling cutters, taps, thread dies, reamers, both solid and shell, hollow mills, punches and dies, and all kinds of sheet metal working tools, shear blades, saws, fine cutlery, and metal cutting tools of all description, as well as for all implements of steel, both large and small. In this work the simplest and most satisfactory hardening and tempering processes are given.

The uses to which the leading brands of steel may be adapted are concisely presented and their treatment for working under different conditions explained, also the special methods for the hardening and tempering of special brands. In connection with the above, numbers of "kinks," "ways," and "practical points" are embodied, making the volume a text book on the treatment of steel as modern demands necessitate.

A chapter devoted to the different processes of **Case-hardening is also included,** and special reference made to **the adoption of Machinery Steel for Tools** of various kinds. The illustrations show the mechanic the most up-to-date devices, machines and furnaces which contribute to the attainment of satisfactory results in this highly important branch of modern tool making. Send for descriptive circular.

MUNN & CO., Publishers, 361 Broadway, New York.

THE

Scientific American Supplement

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers. 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. CHEMISTRY.—Some Properties of the Radiation of Radio-active Bodies 22861
The Conundrums of Radium 22861

II. COMMERCE.—Trade Suggestions from United States Consuls 22877

III. ELECTRICITY.—Contemporary Electrical Science 22860
The Development of Marconi's System of Wireless Telegraphy.—By EMILE GUARINI.—20 illustrations 22864

IV. METALLURGY.—The Krupp Works at Essen.—I.—By DAY ALLEN WILLEY.—6 illustrations 22863

V. MISCELLANEOUS.—Apparent Change of Position of a Target's Bull's Eye 22872
Concrete Floors and Walks 22871
Henequen—The Sisal Fiber of Yucatan.—By E. H. THOMPSON.—5 illustrations 22865
The Planimeter Explained Simply, Without Mathematics.—By W. J. TENNANT.—9 illustrations 22873

VI. NAVAL WARFARE.—Launch of the Argentine Cruiser "Moreno."—By CHAS. DE GRAVE SELLS.—1 illustration 22867

VII. PHOTOGRAPHY.—Color Photography 22867

VIII. PSYCHOLOGY.—Reflections on Thelepathy.—By Prof. JOHN TROWBRIDGE 22863

IX. RAILWAY ENGINEERING.—Report on a Visit to America—By Lieut.-Col. H. A. YORKE 22870

X. TECHNOLOGY.—A New Process of Making Briquettes 22871

XI. TRAVEL AND EXPLORATION.—The Duke Du Bourg de Bozas' Expedition to the Land of the Blue Nile 22872
The Latest Researches About the Discovery of the Continent of America by the Northmen.—By A. GELDEN 22874
Two Recent Visits to the Forbidden City of Lhasa 22875

JUST READY.

DIES, THEIR CONSTRUCTION AND USE,

For the Modern Working of Sheet Metals.

By JOSEPH V. WOODWORTH.

Octavo. Cloth. Very Fully Illustrated. Price $3.00 Postpaid.

This book is a complete treatise on the subject and the most comprehensive and exhaustive one in existence. A book written by a practical man for practical men, and one that no diemaker, machinist, toolmaker or metal-working mechanic can afford to be without.

Dies, press fixtures and devices from the simplest to the most intricate in modern use, are shown, and their construction and use described in a clear, practical manner, so that all grades of metal-working mechanics will be able to understand thoroughly how to design, construct and use them, for the production of the endless variety of sheet-metal articles now in daily use.

Many of the dies described in this book were designed and constructed by the author personally, others under his personal supervision, while others were constructed and used in the press rooms of some of the largest sheet-metal goods establishments and machine shops in the United States. A number of the dies, press fixtures and devices, which form a part of this book, have been selected from over 150 published articles, which were contributed by the author to the columns of the "American Machinist," "Machinery" and the "Age of Steel," under his own name.

No obsolete die, press fixture or device has found a place in this book; every engraving between its covers represents the highest that has been attained in the development of each type described. The descriptions of their construction and use will enable the practical man to adapt them for facilitating, duplicating and expediting the production of sheet-metal articles at the minimum of cost and labor.

Every manager, superintendent, designer, draftsman, foreman, diemaker, machinist, toolmaker or apprentice should have this book.

MUNN & CO., Publishers, 361 Broadway, New York.

The New Supplement Catalogue

Just Published

A large edition of the SUPPLEMENT Catalogue in which is contained a complete list of valuable papers down to the year 1902, is now ready for distribution, free of charge. The new Catalogue is exactly like the old in form, and is brought strictly up to date. All the papers listed are in print and can be sent at once at the cost of ten cents each, to any part of the world. The Catalogue contains 60 three-column pages and comprises 15,000 papers. The Catalogue has been very carefully prepared and contains papers in which information is given that cannot be procured in many text-books published. Write to

MUNN & CO., Publishers, - 361 Broadway, New York,

for the new Catalogue.

PATENTS!

MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for inventors.

In this line of business they have had over *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. MUNN & CO. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

08.

nt

n any
lars a

m the
Price,

a like-
early.
$3.50

AMERI-
MENT,

s and

York.

PAGE

ve
... 2281
... 2283
... 2275
... 2280
97.
... 2284
AY
... 2280
's
... 2272
... 2271
N.
... 2283
By
... 2273
O-
... 2287
... 2287
IN
... 2283
... 2270
... 2271
de
... 2272
of
... 2274
... 2275

USE,

ompre-
actical
maker

tricate
ed in a
hanics
nd use
rticles

ructed
, while
of the
in the
which
d arti-
"Ame-
is own

book;
s been
ons of
them
sheet-

, die-

York.

gue

n-
is
is
e,
ne
ne
ne
in
t-

York,

5!

ation
amine
ts for

Afty
s for
and
nited
Co.
for
n in-
done

rms-
rade
ents.

wing
es of